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Topografia centralnego systemu nerwowego gąsienic
Część II

Топография центральной нервной системы гусениц
Часть II

The topography of the central nervous system of caterpillars
Part II

[Pl. LXVIII—LXXI and 2 text-figures]

INTRODUCTION

In my first paper dealing with the topography of the central nervous system of lepidopterous larvae (1957), I was mainly concerned with the caterpillars of the superfamily *Tineoidea*, feeding in the tissues of leaves.

At that time, the main object of my investigations were living larvae having nervous ganglia with chromatophores on the surface. Immersed in water or in physiological saline, under a cover glass, they were perfectly suited for microscopic examinations. Their transparent skin made it possible to examine the shape, size and position of nervous ganglia in a faultless manner, since they were not distorted by such technical operations like preparation, fixing and staining. In the course of this work, I resorted to preparing only when the ganglia of the caterpillars examined were colourless and, consequently, difficult to be discerned in living specimens.

I examined in such simple way 28 species of *Tineoidea* of the families *Tineidae*, *Nepticulidae*, *Lyonetiidae*, *Gracilariidae* and *Elachistidae*. It turned out that the cephalic genglia are shifted in the tineid caterpillars to the back of the body. Bot the supraoesophageal ganglion (ganglion supraoesophageum) called by many authors the brain of the larvae, as well as the suboesophageal ganglion (ganglion suboesophageum) are not placed in the head, as might have been expected, but in the prothorax [Pl. LXVIII].

Both ganglia are large by comparison to the head of a mining larva, sometimes, especially in young caterpillars, too large to have room enough in the flattened head.

The suboesophageal ganglion lies very close to the first thoracic ganglion, but there is no fusion of the two. In lepidopterous larvae whose nervous system does not exhibit the shift referred to before, there is a considerable distance between the two ganglia; the suboesophageal ganglion is in the head, and the first thoracic ganglion in the centre of the prothorax. In result of the shifting of the suboesophageal ganglion from the head to the thorax, also the first thoracic ganglion of tineid larvae is shifted backwards. It can be found either on the border between the prothorax and the mesothorax, or in the mesothorax.

In the paper referred to before and devoted to the topography of the central nervous system of tineid caterpillars, I mentioned the possibility of a correlation between the shift of the cephalic nervous ganglia from the head to the thorax and the mode of feeding of the larvae examined, which drive corridors and caverns in the parenchyma of leaves, i. e., of the so called mining larvae. However, I did not arrive at any clear and unequivocal conclusions. I merely observed that the shift of the nervous ganglia is likely to be connected with prognathism of the head, which is the invariable character of tineid larvae. I remarked also that only investigations involving the entire order of *Lepidoptera* can afford a satisfactory elucidation of the problem in question.

In addition, I also quoted in the paper results of observations on the number and distribution of ganglia in the ventral nerve cord of tineid caterpillars. I remarked that in the larvae

I examined there were 8 single abdominal ganglia, unlike in the larvae of „*Macrolepidoptera*“ which, as was already reported by BRANDT, 1879 (2) have invariably 7 ganglia.

The results of my work were thus in some disagreement with literature relating to the topography of the central nervous system in caterpillars.

This very fact prompted me to resume studies on the subject, this time with reference to a much more ample material including representatives of not only 5, but 26 families of *Lepidoptera*. Together with leaf-mining larvae I examined, which were the subject of my earlier paper, the species of larvae taken into account in my present publication total 85.

I. Research plan and method.

I. First and foremost I was concerned with:
1. the drawing up of a list of *Lepidoptera* species in whose caterpillars the cephalic nervous ganglia are invariably situated in the head;
2. the drawing up of a list of *Lepidoptera* species in whose caterpillars the cephalic ganglia are permanently or temporarily in the thorax;
3. the detecting of possibly arising relations between the structure of the head, the feeding site of the caterpillars, and the shifting of cephalic nervous ganglia.

II. Moreover, I was concerned with presenting the topography of the ventral nerve cord.

With reference to the plan outlined above, it is necessary to mention some details of the structure of the head in caterpillars.

The position of the head of caterpillars may be twofold. In some of the larvae, the head may be vertical or almost vertical to the longitudinal axis of the body so that the mouth-parts are directed downwards and are on the level of the tarsi; these are larvae of the orthognathous (hypognathous) type of head. In others, the head is horizontal or almost horizontal to, and in the same plane as, the longitudinal axis of the body, so that the mouth-parts and mouth are directed forwards; these are larvae of the prognathous type of head.

Between the two types of head, there may be intermediate forms. Frequently, it is difficult to tell by the eye to which of the two types the larva examined actually belongs. In such cases, the inclination of the head towards the level plane does not provide a sufficient clue. More precise means of distinguishing one type of head from the other have to be chosen.

Here, the method of RIPPLEY (1923) may be of some use; it involves the comparing of the epicranial index calculated for various species of caterpillars.

In the head of lepidopterous larvae (Fig. 1), we may invariably distinguish two hemispheres, i. e., the epicranium, connected by a suture which is given various names. KUZNECOW (1915) calls it sutura metopica, RIPPER (1929) — sutura epicranialis, WEBER (1933) and SNODGRASS (1935) — sutura coronalis. Towards the mouth the suture forks, enclosing on the sides a triangular field considered by SNODGRASS (1935) as the clypeus. The lengths of both the sutura coronalis and the sides of the triangular clypeus, i. e., the sutura epistomalis, vary in the different species of caterpillars. This fact was exploited by RIPPLEY (1923). He introduced the measuring of the so called epicranial index, which represents the proportion between half of the length of the sutura epistomalis, i. e., the side of the clypeus, and the length of the sutura coronalis.

The epicranial index may be less or more than a unit, depending on whether it has been calculated from an orthognathous or a prognathous head. Its value permits the drawing of conclusions as to the degree of orthognathism or prognathism of the head.

I adopted this method for determining the types of cephalic structure and used it in my work. However, my way of calculating the epicranial index differs somewhat from RIPPLEY's method. The difference lies in that the epicranial index indicates in my modification the proportion between the height of the clypeus and the length of the sutura coronalis. Thus, instead of measuring the side of the clypeus, I measure the height of the latter. i. e., the length of an immaginary line drawn from the centre of the base of the clypeal triangle to its vertex. This slight and immaterial modification makes it possible to carry out the measurements with greater precision and speed and I therefore introduced it in my work.

The method of defining by numbers the type of the head structure in caterpillars is no doubt an improvement on the original one, based on the inclination of the head towards the longitudinal axis of the body.

Calculating the index, I strove to avoid inaccuracies in measuring the length of the sutura coronalis and height of the clypeus. The danger is always present, particularly when calculating the indices for heads of the orthognathous type. In the orthognathous type of head the two hemispheres form a vault on the dorsal side of the head and, consequently, the

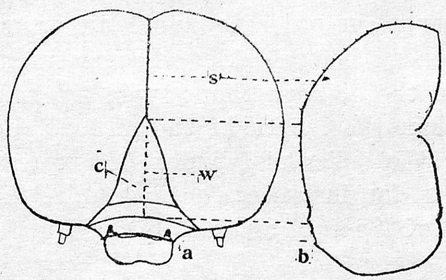

Fig. 1. Diagramatic reproduction of an orthognathous larval head. a. frontal view; b. lateral view; c. height of clypeus (in Fig. „a" it appears equal in length with the sutura coronalis (s), in Fig. „b". the two lengths are represented more correctly, hence, the epicranial index is represented by a fraction, and not by 1 as would follow from measurements taken in position „a".

sutura coronalis has the shape not of a straight line but of a notably convex line. This can be clearly seen when looking at the head from the side.

The height of the clypeus, on the other hand, is more or less rectilinear. When the severed head of the larva is put on its occipital wall for carrying out the measurements, both lines, the height of the clypeus, as well as the sutura coronalis, appear to be rectilinear. When, in such circumstances, the length of lines is measured with the aid of a micrometer eye-piece, an error will be made in calculating the length of the sutura coronalis. Its calculated value will be less than the actual length. Consequently, also the epicranial index will be burdened with an error. In order to eliminate it, I reproduced the outline of the head as seen from the side, with the aid of a drawing apparatus, marking the height of the clypeus and the length of the sutura coronalis; subsequently, I calculated the index [Fig. 1].

Thus, for instance, the epicranial index, calculated after this method for a young caterpillar of *Dicranula vinula* L. (width of the head 2.68 mm), was 0.35, whereas 0.5 was the result obtained when the curvature was not accounted for.

The danger of error is much less in calculating the indices for prognathous types of heads. Absence of a pronounced convexity of the epicranium makes the side view of the sutura coronalis and height of clypeus appear as almost identically arcuate. However, in order to avoid an error here as well, I severed the head before taking the measurements.

In heads of the orthognathous type, the height of the clypeus is less than the length of the sutura coronalis and, consequently, the epicranial index is expressed in proper fractions. Thus, for instance, the epicranial index calculated for the head of *Sphinx pinastri* L., width 5.360 mm, was 0.35.

In heads of the prognathous type, the height of the clypeus exceeds the length of the sutura coronalis. Consequently, the epicranial index is greater than a unit. Thus, for instance, for the larva of *Talaeporia tubulosa* Retz, with of the head 0.790 mm, the epicranial index was 3, and for *Laspeyresia pomonella* L., width of head 0.835—1.613 mm, it was 2.

In the heads of leaf-mining tineid caterpillars, there is frequently complete disappearance of the sutura coronalis and, consequently, no epicranial index can be given for the larvae. This is extreme prognathism of the head.

There are intermediate stages between prognathism and orthognathism. There may be found larvae whose heads are inclined to the horizontal plane by 45°, and not by 90° as in orthognathous types. The epicranial index is here about a unit. For instance, calculated for the head of *Canephora unicolor* Hufn., in the first stage of its life, it was 1.1.

The relation existing between orthognathism, or prognathism, and the mode of feeding of the larvae was already referred to by Ripper (1929). The problem was discussed in my first paper, and I refer to the subject also further below;

however, I should like to stress that the epicranial index has been introduced in my second paper, dealing with the topography of the central nervous system, also with some other object in view. I intended to draw attention to the fact that even the structure of the head and the magnitude of its epicranial index may provide a basis for surmises as to the position the brain is likely to occupy in the body of the larva.

It seems also expedient to quote the width of the head. This grows step-wise with each new stage in the life of the larva, and is more or less constant for each instar of the species. For instance, the relevant figures for *Bucculatrix frangulella* GOEZE are: for the I-st instar 0.083—0.099 mm, for the second instar 0.118—0.125 mm, for the third instar 0.160—0.192 mm, for the fourth and the last instars 0.240—0.282 mm and 0.318—0.360 mm respectively.

For *Antispila petryi* MART. the figures are: in the first instar 0.135 mm, in the second 0.180 mm, in the third 0.284—0.295 mm, and in the fifth and last one 0.400—0.430 mm.

For *Ephestia kühniella* Z., in the first instar 0.198—0.226, in the second 0.272—0.307 mm, in the third 0.409—0.488 mm, in the fourth 0.512—0.579 mm, and so on.

Thus, already the width of the head of a caterpillar makes it possible to determine its age, i. e., its actual instar.

As was mentioned before, while investigating the topography of the central nervous system of caterpillars, I noticed that their brain is usually large in proportion to the head (Fig. 2b),

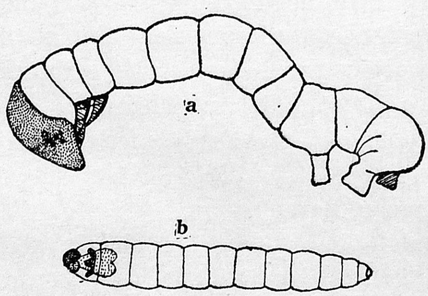

Fig. 2. *Bupalus piniarius* L. — I-st larval instar; lateral view. b. *Ocnerostoma piniariella* Z. Larva removed from a mine. Heads dotted. In larva „a" the brain was in the head, while in „b" it was in the thorax.

larger in the earlier instars of the larvae than in the later ones.

I express also this structural quality of the larval body in figures further below. With this object in view, I quote for each species of the larvae examined the proportion between the width of head and brain for each instar. I termed this ratio the cerebral index. The width of the brain was measured after the brain was removed from the body, or in situ, but not till the larva became entirely quiet. This precaution is indicated, since more intensive movements cause a temporary change in the width of the brain.

It should be clearly stated that the magnitude of the cerebral index is variable. The epicranial index, on the other hand, is for a given instar invariable. This is due to the fact that the size of the head does not change throughout the entire stage: it simply does not grow. Neither the height of the clypeus nor the length of the sutura coronalis change. The head grows step-wise only after ecdysis. The cerebral index, on the other hand, represents a relation between the invariable size of the head and the changing width of the brain. The brain, an internal organ and destitute of a chitin investment, grows normally, and not step-wise, with time. Hence, the cerebral index calculated for a certain instar of the larva is larger after ecdysis than a few days later before the next moult. Consequently, at every new moment of life the larva has a slightly different cerebral index. These differences however, are within one life stage inappreciable, and therefore it appears indicated to quote the index.

Thus, for instance, for seven specimens of *Zygaena sp.* in the first larval instar, I found the cerebral indices to be 1,1; 1,1; 1,1; 1,6; 1,3; 1,2; 1,1, which makes an average of 1,2. For seven specimens of *Ephestia kühniella* Z., in the first larval instar the indices were 1,1; 1,2; 1,1; 1,2; 1,1; 1,3; 1,4, which makes an average of 1,2.

The thus calculated index 1,2 clearly indicates that in the first larval instar of the two species, the width of the brain almost equals that of the head. As for insects, the brain is very large. In the later life stages, as the head grows (it grows at a higher rate than the brain) the cerebral index grows with the head. The greater the index, the smaller the brain in relation to the head. For instance, the cerebral index 3 means that the width of the brain of the given larva is three times less than that of the head.

In my second paper on the topography of the central nervous system of caterpillars, I used a similar technique as in the first one. However, I was forced more frequently to remove the cerebral ganglia from the head or thorax. In many instances I was dealing with nervous systems with weak or no pigmentation, not always visible through the skin.

PARTICULAR INVESTIGATIONS

This paper includes the results of observations involving the nervous system of tineid caterpillars quoted in my first paper devoted to the subject (1957), and the results of new investigations into the nervous system of the following species:

I. of the family *Talaeporidae*:	1. *Talaeporia tubulosa* RETZ.
II. of the family *Bucculatrigidae*:	2. *Bucculatrix crataegi* Z.
III. of the family *Gracilariidae*:	3. *Lithocolletis oxyacanthae* FREY
IV. of the family *Coleophoridae*:	4. *Coleophora virgaureae* STT.
	5. *Coleophora gryphipennella* BOUCHÉ
	6. *Coleophora laricella* HBN.
V. of the family *Hyponomeutidae*:	7. *Ocnerostoma piniariella* Z.
	8. *Argyresthia coniugella* Z.
	9. *Hyponomeuta malinellus* Z.
VI. of the family *Oecophoridae*:	10. *Chimabacche fagella* F.
VII. of the family *Gelechiidae*:	11. *Chrysopora hermannella* F.
	12. *Chrysopora stipella* HBN.
	13. *Gelechia malvella* HBN.
VIII. of the family *Tortricidae*:	14. *Laspeyresia grossana* HW.
	15. *Laspeyresia pomonella* L.
	16. *Evetria resinella* L.
	17. *Cacoecia piceana* L.
IX. of the family *Pyralidae*:	18. *Sylepta ruralis* SC.
	19. *Eurrhypara urticata* L.
	20. *Ephestia kühniella* Z.
	21. *Homoeosoma nimbella* Z.
X. of the family *Psychidae*:	22. *Fumea casta* PALL.

	23. *Fumea crassiorella* Brd.
	24. *Sterhopteryx hirsutella* Hbn.
	25. *Psyche viciella* Schiff.
	26. *Canephora unicolor* Hufn.
	27. *Bacotia sepium* Spr.
XI. of the family *Zygaenidae*:	28. *Zygaena ephialtes v. peucedani* Esp.
	29. *Zygaena sp.*
	30. *Procris statices* L.
XII. of the family *Arctiidae*:	31. *Arctia caja* L.
	32. *Coscinia cribraria* L.
	33. *Spilartia lutea* Hufn.
XIII. of the family *Geometridae*:	34. *Eupithecia pulchellata* Steph.
	35. *Bupalus piniarius* L.
XIV. of the family *Cymathophoridae*:	36. *Thyatira batis* L.
XV. of the family *Noctuidae*:	37. *Cosmia fulvago* L.
	38. *Cuculia verbasci* L.
	39. *Cuculia lactucae* Schiff.
	40. *Polia pisi* L.
	41. *Polia persicariae* L.
	42. *Acronycta rumicis* L.
XVI. of the family *Drepanidae*:	43. *Drepana lacertinaria* L.
XVII. of the family *Lasiocampidae*:	44. *Dendrolimus pini* L.
XVIII. of the family *Lymantriidae*:	45. *Lymantria dispar* L.
XIX. of the family *Notodontidae*:	46. *Phalera bucephala* L.
	47. *Dicranura vinula* L.
	48. *Pheosia tremula* Cl.
	49. *Lophopteryx camelina* L.
XX. of the family *Sphingidae*:	50. *Celerio euphorbiae* L.
	51. *Sphinx pinastri* L.
XXI. of the family *Nymphalidae*:	52. *Araschnia levana* L.
	53. *Vanessa urticae* L.
	54. *Vanessa io* L.
XXII. of the family *Pieridae*:	55. *Gonepteryx rhamni* L.
	56. *Pieris rapae* L.
	57. *Pieris brassicae* L.

The species marked 8, 13, 14, 15, 16, 34 and 37 in the material listed above, live inside stems, buds, flowers, fruits or seeds. It was of considerable importance to account for these species. As mentioned on page 1, all leaf-mining tineid larvae have the brain and suboesophageal ganglion in the prothorax. Hence, it was interesting to investigate whether the relation between endophagism and the shift of the nervous system —

observed in leaf-mining caterpillars — holds also in the case of larvae feeding inside other parts of plants.

The list quoted above includes larvae of 57 species belonging to 47 genera. Together with those studied earlier, they total 85 species and 61 genera.

In addition to these, I studied the situation of the central nervous system in numerous larvae of other species of *Lepidoptera* I do not mention here, since they could not be identified.

Our existing knowledge of the external structure of caterpillars is too scanty to make possible the identification of all species on that evidence. This refers in particular to larvae feeding inside roots, stems, flowers, fruits and seeds, and, occasionally, even to those mining in leaves of plants, for instance, in the needles of conifers. Frequently, the species to which the larva under observation belongs, cannot be determined until final transformation and emergence of the imago. When the insect fails to reach the final instar, identification is frequently impossible. In my work, I was repeatedly confronted with this difficulty, and it is responsible for the fact that the list presented above includes less species than I actually examined. Nevertheless, this material could, and actually did within certain limits, strengthen my belief that I am right in my generalizations presented further below.

DETAILED DESCRIPTION

I. *Talaeporia tubulosa* RETZ. of the family *Talaeporidae*

I found the larvae of the species in the vicinity of Cracow and Krzeszowice, in long cylindrical cases, usually on the trunks of beech trees (*Fagus silvatica* L.) rarely on conifers.

Collected between June and August, the caterpillars were already well advanced in their development. I found no specimens younger than those recorded in the table, and mating tentatives in captivity, in home conditions, were unsuccessful.

Specimens No. No. 5—8 were in their last larval instar. The caterpillars of *Talaeporia tubulosa* RETZ. have a head

Table I

Talaeporia tubulosa Retz.

Cer. i.: cerebral index. Ep. i.: epicranial index

No.	Width of head in mm	Width of brain in mm	Cer. i.	Ep. i.	Date
1.	0,675	0,307	2,3	1,6	30 VI 55
2.	0,712	0,307	2,3	1,8	8 VII 55
3.	0,790	0,329	2,3	2,2	8 VII 55
4.	0,790	0,400	2	3	24 VII 53
5.	0,900	0,363	2,5	?	29 VI 55
6.	0,990	0,341	2,9	2,7	20 VIII 55
7.	1,010	0,341	2,9	2,6	20 VIII 55
8.	1,032	0,442	2,2	2,2	23 VII 53

of the prognathous type and intensive pigmentation of the nervous system; on the surface of ganglia there are numerous pigment cells, with bright nuclei and dark pigment in the plasma. Penetrating light shows a violet-brown coloration of the ganglia [Pl. LXIX 9].

Till the penultimate larval instar is reached, the brain and suboesophageal ganglion remain in the prothorax. In the final instar, there are specimens with the brain in the prothorax, as well as those in which the brain is only partly shifted into the prothorax (No. No. 7 and 8 in the Table).

2. *Bucculatrix crataegi* Z. of the family *Bucculatrigidae*

At Niedźwiedzia Góra near Krzeszowice, I found abandoned mines and free-living larvae outside the mines on *Crataegus monogyna* Jacq. As compared to *Bucculatrix frangulella* Goeze, dealt with in the first paper, the caterpillars were not convenient for studying the nervous system, since the latter is here colourless and is invisible in living specimens. Consequently, the nervous system had to be removed from the body.

a) Width of the head — 0,240 mm; cer. i. 1,2; ep. i. 1,5; Width of the brain — 0,189 mm; 2 VII 54.

b) Width of the head — 0,310 mm; cer. i. — 1,3; ep. i. — 1,7;
Width of the brain — 0,230 mm; 2 VII 54.

Both larvae were examined after they had left the mines. Both had the brain and the suboesophageal ganglion in the prothorax.

3. *Lithocolletis oxyacanthae* Frey of the family *Gracilariidae*

I found the mines, still not in folds, at Niedźwiedzia Góra near Krzeszowice, on *Crataegus monogyna* Jacq. on the underside of leaves.

Width of the head — 0,179 mm; Width of the brain — 0.128 mm. cer. i. — 1,4; ep. i. cannot be calculated.

The brain of the larva, though colourless, was visible in the living specimen. The brain was so long that it could not possibly fit in the head and was entirely in the prothorax.

4. *Coleophora virgaureae* Stt. of the family *Coleophoridae*

In September and October, I found frequently caterpillars of several species in inflorescences of *Solidago Virgaurea* L. growing on glades in the Las Wolski near Cracow. Among others, there were the larvae of *Coleophora virgaureae* Stt. known from Silesia and quoted for that region by S. Toll.

Their heads are of the prognathous type and small in relation to the thickness of the body. They spend apparently their first life stage inside the fruit. The diameter of the head of the youngest ones I found, was just below 200 microns; they were probably in the second instar and a proportion of them had no case yet. It is an interesting fact that there are larvae of the species which have no case not only in the second, but also in subsequent instars, and are living alongside with those that have already built one. This has been recorded in Table II.

The nervous system of *Coleophora virgaureae* Stt. shows against the light a reddish brown, and is well visible in living

Table II

Coleophora virgaureae STT.

No.	Width of head in mm	Width of brain in mm	Cer. i.	Ep. i.	In case	Date
1.	0,180	0,179	1	2,6	no	14 IX 54
2.	0,185	0,150	1,2	2,7	yes	23 IX 54
3.	0,275	0,192	1,4	2	no	13 IX 54
4.	0,318	0,226	1,4	0	no	18 IX 54
5.	0,329	0,239	1,3	1,0	yes	18 IX 54
6.	0,341	0,234	1,4	1,5	yes	18 IX 54
7.	0,341	0,250	1,3	1,4	no	22 IX 54
8.	0,341	0,307	1,1	0	yes	18 IX 54
9.	0,352	0,221	1,6	2,5	no	24 IX 54
10.	0,374	0,250	1,4	2,5	yes	23 IX 54
11.	0,386	0,216	1,7	0	yes	25 IX 54
12.	0,409	0,208	2	1,5	no	23 IX 54
13.	0,409	0,250	1,6	2,4	no	25 IX 54

o — denotes that the epicranial index cannot be calculated

specimens. Consequently it need not be removed and can be studied in vivo.

In all the larvae examined, the brain, together with the connectives, as well as the suboesophageal ganglion, were in the thorax.

5. *Coleophora gryphipennella* BOUCHÉ

In October 1954, I found two caterpillars of *Coleophora gryphipennella* BOUCHÉ on *Rosa canina* L. in the Las Wolski near Cracow. They were in cases, had no fourth pair of prolegs and their heads were of the prognathous type; their nervous system showed brown against the light, darker than the yellow background of the body. They were examined alive. The entire brain and suboesophageal ganglion were in the prothorax.

1. Width of the head — 0,400 mm; Cer. i. — 1,6
   Width of the brain — 0,250 mm; ep. i. — 2
2. Width of the head — 0,400 mm; cer. i. — 1,3
   Width of the brain — 0,295 mm; ep. i. — 2.

6. *Coleophora laricella* Hbn.

I found the larvae of *Coleophora laricella* Hbn. in September, wither in needles of larches (*Larix europaea* D. C.), in which they were mining, or outside the needles in cases. The caterpillars found in the mines were in the first instar and the others in the second one. Till the end of September, I found no older specimens.

The nervous system of all specimens was a rusty brown, and well visible through the skin. Consequently, preparation was superfluous.

In the first instar, sometimes also in the second one, the volume of the brain is so large that the cerebral index is occasionally expressed by a fraction. The length of the brain is in such instances of such substantial length it cannot possibly fit into the head.

Table III

Coleophora laricella Hbn.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date	Locality
1.	I	0,134	0,146	0,9	3,5	28 VIII 55	Nawojowa Góra at Tenczynek
2.	I	0,146	0,115	1,2	3,6	2 IX 55	Niedźwiedzia Góra at Tenczynek
3.	I	0,158	0,152	1,0	3,1	1 IX 55	,, ,,
4.	II	0,188	0,160	1,1	2,2	4 IX 55	,, ,,
5.	II	0,185	0,150	1,2	2,4	12 IX 55	Nawojowa Góra at Tenczynek
6.	II	0,192	0,198	0,9	2,5	2 IX 55	Zwierzyniec at Tenczynek
7.	II	0,218	0,173	1,2	3,2	29 IX 55	Las Wolski near Cracow
8.	II	0,226	0,158	1,4	2	27 IX 55	,, ,,

The entire brain was together with the suboesophageal ganglion in the thorax; in the first instar it extended into the mesothorax and in the second one it was only in the prothorax.

7. *Ocnerostoma piniariella* Z of the family *Hyponomeutidae*

(Fig. 2b, Pl. LXX, 7)

I found the larvae of *Ocnerostoma piniariella* Z in the vicinity of Cracow, in the distal portions of the needles of a pine (*Pinus silvestris* L.). The head of the caterpillars of the prognathous type, and the sutura coronalis is absent in the first and second instars. The head is very small in relation to the length and thickness of the body.

Table IV

Ocnerostoma piniariella Z

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date	Locality
1.	I	0,125	0,192	0,65	0	11 X 54	Las Wolski near Cracow
2.	I	0,124	0,230	0,5	0	3 X 54	,, ,,
3.	I	0,128	0,230	0,5	0	3 X 54	,, ,,
4.	II	0,240	0,204	1,1	0	14 VII 55	Niedźwiedzia Góra
5.	II	0,261	0,192	1,3	0	11 X 54	Las Wolski
6.	II	0,261	0,230	1,1	0	6 VII 55	,, ,,
7.	II	0,265	0,227	1,1	0	23 X 54	,, ,,
8.	II	0,273	0,208	1,3	0	22 X 54	,, ,,
9.	III	0,488	0,307	1,6	?	3 X 54	,, ,,
10.	III	0,488	0,310	1,6	?	2 X 54	,, ,,
11.	IV	0,452	0,352	1,3	3.5	4 VII 55	Zwierzyniec at Tenczynek
12.	IV	0,464	0,341	1,3	3	16 VII 55	Las Wolski
13.	IV	0,464	0,304	1,5	2.4	16 VII 55	,, ,,

Ep. i. = 0, as is cannot be calculated; during transition from the third to the fourth instar, the head fails to grow any more. The fourth instar is the last one, the so called prepupal instar, i. e., praepupa, during which the larva does not feed.

The nervous system is in living larvae but very faintly visible, which makes it frequently necessary to remove the ganglia. The whole of the cerebral and suboesophageal ganglia is in the thorax throughout the four instars, the fourth of which is also the last one.

In the first larval instar of *Ocnerostoma piniariella* Z., the cerebral ganglia extend deep into the mesothorax. As compared to the size of the head, they are very large, exceeding in width and length the corresponding dimensions of the head, so that the cer. i. is expressed by a fraction between 0.65 and 0.5, which can be regarded as quite exceptional. In the subsequent instars the cephalic nervous ganglia are only in the prothorax.

8. *Argyresthia coniugella* Z. of the family *Hyponomeutidae*

The material for studies was collected from sorb-apples (*Sorbus aucuparia* L.) in the vicinity of Krzeszowice. About 38% of the fruit was bored by larvae of *Argyresthia*, which is a quite considerable proportion. However, by summer, when

Table V

Argyresthia coniugella Z.

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date	Locality
1.	0,273	0,169	1,6	1,5	29 VII 54	Niedźwiedzia Góra
2.	0,374	0,211	1,7	1,8	29 VII 54	„ „
3.	0,431	0,284	1,5	1,4	25 VII 54	„ „
4.	0,452	0,250	1,8	2,1	29 VII 54	„ „
5.	0,488	0,250	1,9	1,6	25 VII 54	„ „
6.	0,500	0,239	2	2	3 VIII 54	Nawojowa Góra
7.	0,568	0,239	2,3	2,1	25 VIII 54	Niedźwiedzia Góra
8.	0,579	0,318	1,8	1,7	3 VIII 54	Nawojowa Góra
9.	0,613	0,307	2	1,3	3 VIII 54	„ „
10.	0,635	0,341	1,9	1,5	3 VIII 54	„ „
11.	0,646	0,230	2,8	2,5	3 VIII 54	„ „
12.	0,679	0,292	2,3	1,6	29 VII 54	Niedźwiedzia Góra
13.	0,679	0,307	2,2	1,7	29 VII 54	„ „

I collected my specimens, most of the fruits had been left by the larvae.

The caterpillars fed in the pulp of the fruit driving narrow corridors; they also fed on the contents of seeds.

The brain and the suboesophageal ganglion were in the thorax not only in the youngest specimens, but also in the oldest ones, from No. 8 to No. 13; only in specimen No. 11, with a cerebral index of 2.8, the supraoesophageal ganglion was in the occipital foramen of the head. The nervous ganglia were colourless, imperceptible in living specimens.

9. *Hyponomeuta malinellus* Z. of the family *Hyponomeutidae*

I found numerous concentrations of larvae of *Hyponomeuta malinellus* Z. in June 1955 on all the shrubs of *Rhamnus cathartica* L. growing in the Las Wolski near Cracow. Unluckily, I noticed the concentrations too late, and my studies on the topography of the central nervous system of this species refer merely to the last three larval instars.

When viewed against the light, the nervous ganglia appear a rusty brown and can be seen through the skin of living specimens (No. No. 1—3 in the table). In the penultimate larval instar (No. No. 4—14 in the table) the cerebral ganglia are difficult to be seen in vivo since observation is obstructed by the black scutum of the prothorax. The ganglia of the ventral nerve cord, on the other hand, are well visible.

Studying the topography of the central nervous system of the species, I noted a particularly pronounced ability of the cerebral ganglia to shift backwards at the phase preceding ecdysis, and to return towards the head after the moult is completed. Thus, for instance, in the penultimate larval instars (No. No. 4—14 in the table) the cerebral ganglia were in the occipital foramen, but at the phase preceding ecdysis, when the caterpillars ceased to feed, the entire brain was in the thorax. After ecdysis, the brain shifts towards the head. This fact persuaded me not to consider the measurements of larvae about to moult.

Table VI

Hyponomeuta malinellus Z.

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Position of the brain	Date
1.	0,602	0,318	2	1,8	in the prothorax	8 VI 55
2.	0,545	0,341	1,6	1,9	,, ,, ,,	8 VI 55
3.	0,592	0,341	1,7	1,7	,, ,, ,,	8 VI 55
4.	0,857	0,318	2,6	1,4	in the occipital foramen	9 VI 55
5.	0,823	0,341	2,4	1,1	,, ,, ,,	8 VI 55
6.	0,880	0,341	2,5	1,4	,, ,, ,,	9 VI 55
7.	0,880	0,341	2,5	1,5	,, ,, ,,	9 VI 55
8.	0,869	0,363	2,4	1,9	,, ,, ,,	12 VI 55
9.	0,846	0,374	2,2	?	,, ,, ,,	9 VI 55
10.	0,880	0,374	2,3	1,3	,, ,, ,,	9 VI 55
11.	0,869	0,380	2,2	1,7	,, ,, ,,	12 VI 55
12.	0,900	0,386	2,3	1,5	,, ,, ,,	9 VI 55
13.	0,900	0,386	2,3	1,6	,, ,, ,,	12 VI 55
14.	0,900	0,386	2,3	1,4	,, ,, ,,	9 VI 55
15.	1,336	0,386	3,4	1,6	in the head	12 VI 55
16.	1,440	0,420	3,4	1,5	,, ,, ,,	12 VI 55
17.	1,350	0,420	3,2	1,1	,, ,, ,,	12 VI 55
18.	1,262	0,431	3	1,2	,, ,, ,,	14 VI 55
19.	1,285	0,450	2,8	1	,, ,, ,,	13 VI 55

The brain of the youngest larvae (No. No. 1—3 in the table) was situated outside the head, in the prothorax, and at the penultimate instar in the occipital foramen. In this instar, a slight pressure, applied to the cover glass over the head submerged in water, causes the cerebral ganglia to shift outside the head. In the last instar, the brain lies somewhat deeper in the head. In this case, slight pressure on the cover glass fails to cause the brain to shift outside. In the last three instars, the suboesophageal ganglion lies outside the head, in the prothorax, where it was to be found most certainly also in the preceding instars.

In the ventral nerve cord primitive relations may be distinguished. Ganglia 7-th and 8-th are entirely separated from one another, the interganglíar distance being equal to that observed, for instance, in larvae of *Nepticula myrtilella* Stt. Further details will be presented on page 64 a.

10. *Chimabacche fagella* F. of the family *Oecophoridae*

I found the larvae — easily recognized by the structure of the third pair of legs — between July and September, most frequently between spun together leaves of *Fagus silvatica* L., *Crataegus monogyna* Jacq.., *Cornus sanguinea* L., and even *Rosa canina* L.

Table VII

Chimabacche fagella F.

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date	Locality
1.	0,568	0,284	2	1,3	2 VII 54	Niedźwiedzia Góra
2.	0,880	0,363	2,4	1,5	17 VII 54	,, ,,
3.	0,880	0,324	2,7	1,6	31 VII 54	Nawojowa Góra
4.	0,889	0,386	2,3	1,5	24 VII 54	Niedźwiedzia Góra
5.	0,967	0,374	2,5	1,6	31 VII 54	Nawojowa Góra
6.	1,240	0,400	3	1,3	27 VII 54	Niedźwiedzia Góra
7.	1,350	0,400	3,3	1,5	31 VII 54	Nawojowa Góra

Among all the larvae of *Chimabacche fagella* F. examined, the first specimen was the youngest one, but even this was fairly advanced in development. The nervous ganglia, though colourless, were discernible in living specimens. The brain was partly covered by the epicranium but the most part of it extended beyond the head into the prothorax. In older specimens (No. No. 2—5) the brain was almost entirely covered by the epicranium. It might be said that the brain was in the occipital foramen on the head. It was thus slightly shifted backwards, but not so much so as in the first larva. In the oldest specimens (No. No. 6 and 7) the brain was in the head.

11. *Chrysopora hermannella* F. of the family *Gelechiidae*

I found the mines inhabited by larvae of *Chrysopora hermannella* F. in July and August in leaves of *Chenopodium album* L., in the neighbourhood of Cracow. The larvae in the mines were in the II, III and IV instars when I collected them. In the fourth instar, they left the leaves and pupated. Imagines emerged already in October.

Table VIII

Chrysopora hermanella F.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	II	0,220	0,203	1	5,4	17 VIII 55
2.	II	0,250	0,180	1,4	0	29 VIII 55
3.	III	0,363	0,284	2	?	28 VIII 54
4.	III	0,386	0,214	1,8	4	11 VII 55
5.	III	0,400	0,203	almost 2	5	11 VII 55
6.	III	0,400	0,295	1,3	4	29 VIII 55
7.	IV	0,568	0,273	2	?	28 VIII 54
8.	IV	0,590	0,329	1,7	3	29 VIII 55
9.	IV	0,624	0,318	2	3	31 VIII 54
10.	IV	0,624	0,341	1,8	4	28 VIII 55

The heads of the larvae of *Chrysopora hermannella* F. are of the prognathous type. Their colourless nervous system is rather faintly discernible in vivo. Hence, preparation is frequently necessary.

The entire brain and suboesophageal ganglion remains in the first three instars in the prothorax. In the fourth, i. e., the final larval instar, the brain is partly covered by the occiput, the rest of it being situated outside the head, in the prothorax. The suboesophageal ganglion is also in this instar entirely in the prothorax.

12. *Chrysopora stipella* Hbn. of the family *Gelechiidae*

Similarly as in the case of *Chrysopora hermannella* F., I found the mines inhabited by larvae of *Chrysopora stipella* Hbn. in July and August in various localities near Cracow in the leaves of *Chenopodium album* L.

When they were collected, the larvae in the mines were in the II, III or IV instar.

Table IX

Chrysopora stipella Hbn.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	II	0,192	0,160	1,2	4	29 VIII 55
2.	III	0,301	0,226	1,3	3	18 VIII 54
3.	III	0,307	0,261	1,2	3,5	31 VIII 54
4.	III	0,316	0,226	1,4	4	11 VII 55
5.	III	0,363	0,250	1,4	3,5	11 VII 55
6.	IV	0,512	0,307	1,6	3,5	12 VII 55
7.	IV	0,568	0,250	2,1	3,4	29 VIII 55
8.	IV	0,568	0,273	2	?	28 VIII 54
9.	IV	0,568	0,318	1,8	4,2	18 VIII 55

The larvae of *Chrysopora stipella* Hbn. have heads of a prognathous type and a black scutum on the prothorax obstructing observation of the situation of the brain in living specimens: the nervous system is colourless, indistinctly visible in vivo.

The whole of the cephalic ganglia is throughout the first three instars in the prothorax. In the fourth, i. e., in the final larval instar, the brain is partly covered by the epicranium, but most of it is in the prothorax.

13. *Gelechia malvella* Hbn. of the family *Gelechiidae*

I found the larvae of *Gelechia malvella* Hbn. in unripe fruits of *Malva alcea* L. on Niedźwiedzia Góra near Tenczynek. They were driving corridors and feeding inside the seeds.

Table X

Gelechia malvella Hbn.

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	0,624	0,284	2,2	2	14 VIII 54
2.	0,749	0,284	2,6	2,3	14 VIII 54
3.	1,130	0,341	3,3	1,6	14 VIII 54

The ganglia of the larvae were brown, the ventral nerve cord was partly visible in living specimens. The entire brain and suboesophageal ganglion of younger specimens (No. No. 1 and 2) were in the prothorax, while the brain of the third specimen was in the occipital foramen.

14. *Laspeyresia grossana* Hw. of the family *Tortricidae*

[Pl. LXIX, 3]

I found the larvae of *Laspeyresia grossana* Hw., in beechnuts (*Fagus silvatica* L.) on July 23, 1953, in the Las Wolski near Cracow. The beech-trees cropped poorly in the year, and there were few larvae. The nervous ganglia of living specimens were imperceptible. Only one specimen was examined.

Width of the head — 0.557 mm, Width of the brain — 0,226 mm. Cerebral index — 2,4, Epicranial index — 2,5

The brain of the larva was in the prothorax.

15. *Laspeyresia pomonella* L. of the family *Tortricidae*

I found the larvae in apples bought on the market in Cracow.

Table XI

Laspeyresia pomonella L.

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	0,835	0,386	2,2	2,4	29 VII 53
2.	1,077	0,400	2,7	2	29 VII 53
3.	1,090	0,400	2,7	2	29 VII 53

The larvae examined were about to conclude their development. Their nervous system was colourless; the brain and the suboesophageal ganglion were only in part in the prothorax. It ought to be assumed that, in the initial instars, the brain and suboesophageal ganglion are as a whole shifted into the thorax.

16. *Evetria resinella* L. of the family *Tortricidae*

[Pl. LXX, 12, Pl. LXXI, 13]

As is known, the larvae of this species feed in the shoots and buds of pines (*Pinus silvestris* L.), giving rise to resin galls. They feed over two years. I collected the material for my studies in the environments of Cracow and Krzeszowice; the material included specimens in the first and second year of life.

Table XII

Evetria resinella L.

I-st year of life

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date	Locality
1.	0,431	0,295	1,4	3,6	23 VIII 53	Nawojowa Góra
2.	0,452	0,250	1,8	2,7	23 VIII 53	,, ,,
3.	0,464	0,341	1,4	3,2	18 IX 53	Las Wolski
4.	0,476	0,338	1,4	3,4	26 VII 53	Nawojowa Góra
5.	0,488	0,318	1,5	3,4	1 VIII 53	Niedźwiedzia Góra
6.	0,500	0,295	1,5	2,7	1 VIII 53	,, ,,
7.	0,523	0,295	1,7	?	12 VIII 53	,, ,,
8.	0,529	0,245	2,1	4,6	26 VII 53	Nawojowa Góra
9.	0,590	0,329	1,7	4,4	26 VII 53	,, ,,

II-d year of life

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date	Locality
10.	0,882	0,368	2,4	2	3 VII 53	Niedźwiedzia Góra
11.	1,000	0,488	2	2,4	10 VIII 53	Nawojowa Góra
12.	1,000	0,366	2,7	2,9	6 VII 53	Tenczynek
13.	1,043	0,420	2,4	2,3	4 IX 53	Nawojowa Góra
14.	1,130	0,590	1,9	2,6	20 VIII 53	,, ,,
15.	1,130	0,452	2,5	2	25 VIII 53	Tenczynek
16.	1,186	0,568	2	2,7	28 VIII 53	,,
17.	1,186	0,523	2,2	2,6	28 VIII 53	,,

Specimens from 1 to 5 were probably in their first instar, and specimens from 6 to 9 in the second one. In all the specimens examined (first as well as second year of life), the brain and the suboesophageal ganglion were in the thorax. However, in the second year of life, the brain was partly covered by the epicranium.

17. *Cacoecia piceana* L. of the family *Tortricidae*

In August and September I found the larvae of this species in the vicinity of Krzeszowice, mostly between spun together needles of the pine (*Pinus silvestris* L.), rarely in mines inside the needles.

The larvae of *Cacoecia piceana* L. are known to feed in autumn and, after hibernation, in spring, whereas the imagines usually fly between June and August. Cultivated at home, the larvae grew only till a certain instar in which their heads attained the diameter of about 700 microns. It turned out that between September 6, 1955, and October 20, 1955, that is over a period of 44 days, they underwent no ecdysis, although the ambient temperature was about + 18°C. For this reason, the table further below, concerning material collected between the middle of August and the middle of October, includes merely data relating to 3 instars. As an exception, one of the larvae, found on August 14-th 1955, between spun together

Table XIII

Cacoecia piceana L.

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Where collected	Date
1.	0,452	0,261	1,7	3	in a mine	18 VIII 54
2.	0,500	0,284	1,7	2	in a mine	28 VIII 55
3.	0,500	0,284	1,7	2,3	outside a mine	28 VIII 55
4.	0,512	0,261	1,9	1,7	,, ,,	18 VIII 54
5.	0,512	0,307	1,7	2,5	in a mine	16 VIII 54
6.	0,512	0,329	1,5	2	in a mine	18 VIII 54
7.	0,624	0,329	1,5	1,8	outside a mine	17 IX 55
8.	0,690	0,330	2	2	,, ,,	12 IX 55
9.	0,690	0,341	2	2,7	,, ,,	12 IX 55
10.	0,700	0,374	1,8	2	,, ,,	12 IX 55
11.	0,712	0,341	2	1,7	,, ,,	12 IX 55
12.	1,735	0,452	3,8	1,6	,, ,,	22 X 55

needles, grew at a relatively rapid rate, developed normally and on September 29-th, 1955, a mature male left the puparium.

Another one, found on September 9-th, 1955, continued to develop normally till October 22-nd, 1955, and served for examinations of the nervous system (No. 12 in the table).

The heads of the larvae of *Cacoecia piceana* L. were of the prognathous type. There was intensive pigmentation of the nervous system, and the latter was well visible in vivo. The entire brain and suboesophageal ganglion were in the prothorax.

On the other hand, in specimen No. 12, about to conclude its development, the brain was in the head and the suboesophageal ganglion in the occipital foramen. I interpret these differences in the situation of the ganglia in question between younger and the oldest specimens, as a result of the unusually rapid growth of the head in larvae of this species. The diameter of the head grew by about 700 microns, whereas the brain grew at the same time only by about 100 microns in diameter.

18. *Sylepta ruralis* Sc. of the family *Pyralidae*.

I collected the larvae of this species from rolled up leaves of *Urtica dioica* L. in the environments of Cracow and Krzeszowice. Unfortunately, I noticed them too late, in July 1954, at a time when they were about to conclude their development. I examined the nervous system of one specimen only, since the results obtained made further examinations of specimens of the same age group superfluous.

Width of the head — 1,876; Width of the brain — 0,400; Cer. i. — 4; ep. i. — 1,2; 4 VII 54.

At that age, the heads of the larvae of *Sylepta ruralis* Sc. are between the prognathous and the orthognathous types, and the cerebral index is relatively large. Hence, the brain and the suboesophageal ganglion lay in the head. It may be that in the earlier instars the cephalic ganglia are in the prothorax, as in the larvae of *Ephestia kühniella* Z. of the same family, and in many others which I put in category II (see p. 51).

19. *Eurrhypara urticata* L. of the family *Pyralidae*

I found *Eurrhypara urticata* L. larvae in July and August in spun together leaves and buds of the apical sections of shoots of *Urtica dioica* L.

Table XIV

Eurrhypara urticata L.

Four final instars

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Position of the brain	Date	Locality
1.	0,295	0,226	1,3	2	in the prothorax	30 VII 55	Tenczynek ad Krzeszowice
2.	0,295	0,250	1,1	2,3	,, ,,	30 VII 55	,,
3.	0,318	0,217	1,4	1,8	,, ,,	30 VII 55	,,
4.	0,329	0,307	1,1	1,7	,, ,,	29 VII 55	,,
5.	0,540	0,307	1,7	1,7	partly in the head and partly in the prothorax	29 VII 55	,,
6.	0,523	0,295	1,7	1,6		29 VII 55	,,
7.	0,523	0,295	1,7	2,2		29 VII 55	,,
8.	0,539	0,341	1,5	1,9	,, ,,	29 VII 55	,,
9.	0,590	0,352	1,7	1,7	,, ,,	29 VII 55	,,
10.	0,800	0,409	2	2,1	in the occipital foramen	26 VII 55	,,
11.	0,800	0,420	2	1,7	,, ,,	26 VII 55	,,
12.	0,823	0,370	2,2	1,5	,, ,,	26 VII 55	,,
13.	0,889	0,420	2,1	2,1	,, ,,	26 VII 55	,,
14.	0,922	0,374	2,4	2	,, ,,	5 VIII 55	,,
15.	1,440	0,488	2,9	3	,, ,,	14 VIII 55	,,
16.	1,440	0,500	2,7	2,1	,, ,,	22 VIII 55	,,

The nervous system of caterpillars of *Eurrhypara urticata* L. is colourless and appears white in reflected light. Hence, it is difficult to discern the brain and to determine its width. The difficulty is aggravated by the presence, next to the head, of large glands which obstruct the view of the brain from above. Consequently, preparation is frequently necessary.

In the life stage No. No. 1—4 the brain and the suboesophageal ganglion are in the prothorax; in the next stage, No. No. 5—9, 2/3 of the brain are in the head and 1/3 still in the prothorax, while in subsequent stages the whole of it is in the head.

20. *Ephestia kühniella* Z. of the family *Pyralidae*

[Pl. LXIX, 2, Pl. LXXI, 16 and 17]

I cultivated the species in Petri dishes.

Table XV

Ephestia kühniella Z.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	I	0,198	0,173	1,1	3	23 I 54
2.	I	0,208	0,164	1,2	3,8	28 I 54
3.	I	0,211	0,192	1,1	3,3	24 I 54
4.	I	0,211	0,176	1,2	2,8	25 I 54
5.	I	0,211	0,185	1,1	3,4	24 I 54
6.	I	0,214	0,160	1,3	3	19 I 54
7.	I	0,214	0,153	1,4	3	19 I 54
8.	II	0,272	0,233	1,2	1,8	29 I 54
9.	II	0,295	0,230	1,2	2,4	27 I 54
10.	II	0,295	0,208	1,4	2,3	27 I 54
11.	II	0,295	0,214	1,2	2,4	29 I 54
12.	II	0,307	0,227	1,3	2,4	28 I 54
13.	II	0,307	0,226	1,3	?	23 VIII 53
14.	III	0,409	0,295	1,4	2	3 VIII 53
15.	III	0,442	0,240	1,8	2	29 I 54
16.	III	0,452	0,307	1,4	2	23 VIII 53
17.	III	0,452	0,307	1,4	2	24 VIII 53
18.	III	0,488	0,386	1,3	2	23 VIII 53

ctd. Table XV

19.	?	0,512	0,269	1,9	1,8	25 II 54
20.	?	0,579	0,318	1,8	2	25 II 54
21.	?	0,701	0,330	2,1	2	23 II 54
22.	?	0,758	0,341	2,2	1,6	11 IX 53
23.	?	0,814	0,352	2,3	1,4	13 II 54
24.	?	1,077	0,512	2,1	2,5	2 VIII 53
25.	?	1,163	0,476	2,4	1,8	11 IX 53
26.	?	1,240	0,420	3	2,2	24 VIII 53

In the first larval instar, the brain and the suboesophageal ganglion of *Ephestia kühniella* Z. are in the thorax. The brain is relatively very large, almost the width of the head, and extends as far as into the mesothorax, occasionally even into the proximal part of the metathorax.

Since the nervous system of the larvae is colourless, it is rarely possible to determine in vivo the limit attained by the brain. Transparence was found greatest in larvae grown in Petri dishes in which the flour was almost entirely eaten up.

In the second and third instars, the brain and the suboesophageal ganglion of the larvae are still in the prothorax. In further stages the brain is partly covered by the epicranium. When the head was 0.814 mm wide, only an insignificant proportion of the brain extended into the prothorax.

21. *Homoeosoma nimbella* Z. of the family *Pyralidae*

I found the larvae of the species in August in faded inflorescences of *Senecio Jacobaea* L. The imagines emerged between the 15-th and the 18-th of September 1954.

The brain and suboesophageal ganglion of specimens No. No. 1—6 were as a whole in the thorax; the brain of specimen 7 was between the head and the thorax, a part of it in the thorax. The nervous system of living larvae could be discerned with difficulty.

Table XVI

Homoeosoma nimbella Z.

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date	Locality
1.	0,192	0,158	1,2	2,5	9 VIII 54	Nawojowa Góra
2.	0,329	0,284	1,1	1,6	10 VIII 54	,, ,,
3.	0,329	0,284	1,1	1,3	19 VIII 54	,, ,,
4.	0,341	0,261	1,3	1,7	9 VIII 54	,, ,,
5.	0,341	0,252	1,3	1,7	9 VIII 54	,, ,,
6.	0,341	0,239	1,4	1,7	9 VIII 54	,, ,,
7.	0,758	0,462	1,6	1,4	19 VIII 54	,, ,,

22. *Bacotia sepium* SPR. of the family *Psychidae*

On June 19-th, 1955, I found only a single specimen in a case on the trunk of a beech-tree (*Fagus silvatica* L.) in the Las Wolski near Cracow.

Width of the head — 1.010 mm; width of the brain — 0.442 mm; Cerebral index — 2,2; Epicranial index — 1,7

The nervous ganglia were dark as in other species of the family *Psychidae* and the brain was in the prothorax.

23. *Fumea casta* PALL. of the family *Psychidae*

[Pl. LXXI, 14]

I collected larvae in cases, and females on the trunks of trees on Niedźwiedzia Góra. Between the 5-th and the 24-th of August 1953, larvae hatched from eggs, in numbers of 70—90 from one case.

I interrupted my examinations of the nervous system at the fourth larval instar and I did not continue them in spring 1954. Metamorphosis took place in May, always towards the evening.

In all the instars examined the head was prognathous and the brain and suboesophageal ganglion were in the prothorax.

The position of the brain during the last phase of the life of the larvae remains still to be ascertained.

Table XVII

Fumea casta Pall.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	I	0,288	0,224	1,3	1,7	13 VII 53
2.	I	0,297	0,169	1,7	1,5	5 VII 53
3.	II	0,341	0,256	1,3	1,2	19 VII 53
4.	II	0,341	0,284	1,2	1,4	24 VII 53
5.	II	0,352	0,246	1,4	1,5	19 VII 53
6.	II	0,352	0,243	1,4	1,7	19 VII 53
7.	III	0,464	0,290	1,6	1	24 VII 53
8.	III	0,512	0,284	1,8	1,4	24 VII 53
9.	III	0,523	0,307	1,7	1	24 VII 53
10.	III	0,579	0,251	2,3	1,3	24 VII 53
11.	IV	0,624	0,290	2,2	1,4	21 IX 53
12.	IV	0,657	0,307	2,1	1,4	8 VIII 53
13.	IV	0,679	0,318	2,1	1,6	8 VIII 53
14.	IV	0,690	0,329	2	1,1	6 IX 53

The larvae of *Fumea casta* Pall., like those of *Fumea crassiorella* Brd. are very convenient for studies of the topography of the central nervous system. The nervous ganglia are of an intense colour and well visible through the skin in the ventral nerve cord. Only the brain is covered by the scutum thoracale dorsale which is situated on the prothorax.

24. *Fumea crassiorella* Brd.

Studies of the nervous system gave results very much like those quoted for *Fumea casta* Pall.

25. *Sterhopteryx hirsutella* Hbn. of the family *Psychidae*

The larvae hatched on July 15-th, 1953, from a case collected on June 28-th, 1953, from a leaf of an alder (*Alnus glutinosa* (L.) Gaertn). in Las Wolski near Cracow. Imagines failed to emerge and I determined the species by comparing the case with identified ones kept in the Institute of Zoology of the Polish Academy of Sciences, Branch at Kraków.

Table XVIII

Sterhopteryx hirsutella Hbn.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	I	0,442	0,290	1,5	2	17 VII 53
2.	I	0,476	0,256	1,8	2	17 VII 53
3.	II	0,534	0,347	1,5	1,6	27 VII 53
4.	III	0,712	0,352	2	1,5	15 VIII 53
5.	III	0,780	0,363	2,1	1,4	9 VIII 53
6.	IV	0,956	0,409	2,3	1,3	21 IX 53
7.	IV	0,967	0,400	2,4	1,4	31 VIII 53
8.	IV	0,990	0,409	2,4	1,4	20 IX 53
9.	IV	1,010	0,431	2,3	1,5	20 IX 53

Examinations of the nervous system involved 9 specimens. During the exceptionally severe winter the larvae perished and further examinations in spring were thus impossible.

The black scutum on the prothorax and almost chocolate brown coloration of the skin, made it difficult to examine the nervous system in living specimens. Nevertheless, some details of the topography of the ventral nerve cord could be discerned. Preparations revealed that the brain as a whole is throughout the first three instars in the prothorax, and in the fourth instar it is partly covered by the epicranium. The suboesophageal ganglion is in the prothorax.

26. *Psyche viciella* Schiff. of the family *Psychidae*

I found the case with the larva on August 17-th, 1955, on a leaf of *Salix aurita* L. at Tenczynek. The larva was well advanced in development.

Width of the head — 1,440 mm; Width of the brain — 0.500 mm; Cer. i. — 2.8; Ep. i. — about 1.

The larva was not transparent and, consequently, the ganglia had to be taken out. Preparation revealed that the brain and suboesophageal ganglion were in the occipital foramen.

27. *Canephora unicolor* Hufn. of the family *Psychidae*

The larvae hatched on July 9-th, 1953, from a case found in the Las Wolski.

Table XIX

Canephora unicolor Hufn.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	I	0,442	0,341	1,2	1,1	9 VII 53
2.	II	0,568	0,409	1,3	?	23 VII 53
3.	II	0,590	0,347	1,7	1,2	23 VII 53
4.	II	0,602	0,307	1,9	1,3	23 VII 53
5.	III	0,812	0,400	2	1,3	23 VII 53
6.	III.	0,880	0,352	2,5	1,3	1 VIII 53
7.	IV	1,043	0,415	2,5	1,6	7 IX 53
8.	IV	1,111	0,420	2,6	1,2	7 IX 53
9.	IV	1,130	0,452	2,5	1,4	7 IX 53
10.	IV	1,130	0,452	2,5	1,6	7 IX 53
11.	V ?	1,608	0,409	3,9	1,5	20 IX 53

The nervous ganglia of caterpillars of *Canephora unicolor* Hufn. are of an intensive colour and can be easily removed. This facilitates considerably examination of the nervous system.

The brain and the suboesophageal ganglion are in the first and second instars in the prothorax. In the third instar, a half of the brain was still outside the head in the prothorax, but at the fourth instar merely its broadest part, the protocerebrum, extended beyond the head into the prothorax. The brain of the larvae of this species was found to show minimum growth in width.

28. *Zygaena ephialtes* var. *peucedani* Esp. of the family *Zygaenidae*

A female of the species was collected on Niedźwiedzia Góra near Tenczynek, and it deposited eggs at home on August 14-th, 1955. On August 24-th, 1955, larvae hatched from the eggs and a part served for examination.

Table XX

Zygaena ephialtes var. *peucedani* Esp.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	I	0,341	0,226	1,5	1,5	24 VIII 55
2.	I	0,352	0,261	1,3	1,5	28 VIII 55
3.	I	0,400	0,284	1,4	1,5	24 VIII 55
4.	II	0,523	0,295	1,7	1,4	1 IX 55
5.	II	0,464	0,318	1,4	1,3	4 IX 55
6.	III	0,613	0,341	1,7	1,2	14 IX 55
7.	III	0,646	0,400	1,6	1,3	14 IX 55

When the larvae reached their third instar, I interrupted further examinations.

The heads of larvae of *Zygaena ephialtes* var. *peucedani* Esp. are prognathous but less flat than, for instance, in *Ti-*

neoidea. The larvae hold the head usually vertically, in which they are aided by the structure of the prothorax whose dorsal aspect is much longer than the ventral one and makes possible a vertical position of the head in spite of the prognathous type of structure [Pl. LXX, 6]. The larvae are also capable of retracting the head into the thorax.

The brain and the suboesophageal ganglion are in the first and second instars in the prothorax [Pl. LXX, 11]. Between the suboesophageal and the first thoracic ganglia there are short connectives.

When a larva holds its head downwards, the cerebral hemispheres, usually facing backwards in a horizontal plane, are directed upwards [Pl. LXX, 6].

In the third instar, the cerebral ganglia are already in the head, in the occipital foramen. Slight pressure causes them to shift outside, but they return to the original position when the pressure is released.

The suboesophageal ganglion is at that instar in the prothorax.

In the abdominal nerve cord there can be discerned the primitive relations. All ganglia in the cord are separate. Ganglia 7-th and 8-th are linked by fairly long connectives [Pl. LXX, 8], like in *Hyponomeuta malinellus* Z.

The relations in the topography of the central nervous system in other larvae of the genus *Zygaena* F. are quite similar.

29. *Zygaena* sp.

[Pl. LXX, 6, 8, 11]

On July 21-st, 1953, I found eggs deposited by a species of the genus *Zygaena* F. on a twig of *Pinus silvestris* L., growing on Nawojowa Góra near Tenczynek. The larvae hatched on July 28-th and fed till autumn on *Coronilla varia* L. In the course of the severe winter, the larvae perished and the species could not be identified, since no imagines emerged. In the next year, 1954, on August 4-th, I collected two specimens of *Zygaena achilleae* Esp. The female deposited eggs on leaves of *Coronilla varia* L. The larvae hatched on August 16-th, 1954, and were of the same coloration as those examined in 1953. Examinations confirmed the results obtained in 1953.

Table XXI

Zygaena achilleae Esp.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	I	0,320	0,278	1,1	1,3	29 VII 53
2.	I	0,336	0,281	1,1	1,2	28 VII 53
3.	I	0,341	0,284	1,2	1,1	28 VII 53
4.	I	0,352	0,300	1,1	1,1	28 VII 53
5.	I	0,352	0,217	1,6	1,3	21 VIII 53
6.	I	0,352	0,307	1,1	1,1	21 VIII 53
7.	I	0,363	0,265	1,3	1,2	21 VIII 53
8.	II	0,464	0,313	1,5	1,2	30 VIII 53
9.	II	0,500	0,307	1,6	1,2	30 VIII 53
10.	II	0,590	0,363	1,9	1,1	8 IX 53
11.	III	0,679	0,363	1,9	1,1	9 IX 53

I interrupted further examinations of the nervous system in the third larval instar. The nervous system of the *Zygaena* sp. examined was colourless, but shadows of the ganglia were visible against the light through the skin.

The heads of caterpillars of *Zygaena* sp. are between the prognathous and the orthognathous types. The head is usually held vertically, which is favoured by the structure of the prothorax, similarly as in the case of larvae of *Zygaena ephialtes* var. *peucedani* Esp.

As compared to the latter species, the nervous system of the *Zygaena sp.* examined was much wider at a similar width of the head. Otherwise the topography of the nervous system of the two species was entirely concordant. The reproductions included in the paper relate to this material.

30. *Procris statices* L. of the family *Zygaenidae*

A female of *Procris statices* L. collected on August 15-th, 1955, on Niedźwiedzia Góra near Tenczynek, deposited her eggs at home on the walls of the jar in which it was kept and partly on a leaf of *Coronilla varia* L. The larvae hatched on August 25-th and fed on leaves of dock *(Rumex* sp.*)*.

Over a period of 4 weeks they grew little and failed to moult; consequently, I discontinued cultivation.

Table XXII

Procris statices L.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	I	0,214	0,226	0,9	2	25 VIII 55
2.	I	0,214	0,226	0,9	2,3	25 VIII 55
3.	I	0,239	0,226	1	1,8	27 VIII 55
4.	I	0,226	0,273	0,8	2	1 IX 55
5.	I	0,214	0,261	0,8	2	4 IX 55

The nervous system of the larvae was visible in living specimens. Their entire brain, wider then the head, was in the prothorax.

31. *Arctia caja* L. of the family *Arctiidae*

I found several very young larvae, probably in their first instar, on August 25-th, 1954, on a leaf of a nettle (*Urtica dioica* L.) at the village Rudno near Tenczynek. One of these was examined.

Width of the head — 0,646 mm; Cer. i. — 1,4;

Width of the brain — 0,442 mm; Ep. i. — 1,2.

The brain and the suboesophageal ganglion of the larva were in the prothorax. In addition, I took measurements from an *Arctia caja* L. specimen in its final larval instar, which was seeking a suitable place for pupation.

Width of the head — 3,752 mm; Cer. i. — 3,7;
Width of the brain — 1,010 mm; Ep. i. — 1,4.

The brain and suboesophageal ganglion of the specimen was in the head.

The ganglia 7-th and 8-th of the ventral nerve cord were grown together into a single unit; its double nature was betrayed, however, by the nerves starting from it and by the tracheae supplying it.

32. *Coscinia cribraria* L. of the family *Arctiidae*

[Pl. LXIX, 4]

On July 21-st, 1953, I found a female *Coscinia cribraria* L. sitting on a twig of the pine (*Pinus silvestris* L.) growing on Niedźwiedzia Góra near Tenczynek. Underneath the female, there was a short string of eggs, from which larvae hatched on July 29-th, 1953. They fed on heath (*Calluna vulgaris* Salisb.) and later on whortleberry (*Vaccinium myrtillus* L.) which they apparently preferred. I chose five specimens of the scanty material for examinations of the nervous system.

The larvae of *Coscinia cribraria* L. held the head vertically already in the first instar, although their epicranial index corresponded to structures between the orthognathous and the prognathous types. The nervous ganglia were brown and well visible through the transparent skin.

Table XXIII

Coscinia cribraria L.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	I	0,352	0,313	1,1	1,4	29 VII 53
2.	II	0,476	0,318	1,5	1,2	13 VIII 53
3.	III	0,624	0,386	1,6	1,1	21 VIII 53
4.	IV	0,801	0,452	1,8	1,2	8 IX 53
5.	IV	0,846	0,400	2,1	0,8	5 IX 53

In the first and second instars, the brain and the suboesophageal ganglion were as a whole in the prothorax, and in the third instar, the brain was partly covered by the epicranium. At the fourth instar the brain was in the head and did not extend into the prothorax.

33. *Spilarctia lutea* HUFN. (= *lubricipeda* L.) of the family *Arctiidae*

[Pl. LXIX, 5]

A female *Spilarctia lutea* HUFN., collected on July 21-st, 1955, at Tenczynek near Krzeszowice, deposited at home, in the course of four days, 442 eggs. A week later, the larvae began to hatch and a part of these served for examinations.

Table XXIV

Spilarctia lutea HUFN.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	I	0,400	0,284	1,4	1,4	1 VIII 55
2.	I	0,409	0,295	1,3	1,5	1 VIII 55
3.	I	0,420	0,295	1,4	2,2	28 VII 55
4.	I	0,409	0,307	1,3	1,4	1 VIII 55
5.	II	0,568	0,318	1,7	1,5	6 VIII 55
6.	II	0,579	0,341	1,7	1,3	6 VIII 55
7.	II	0,579	0,341	1,7	1,5	6 VIII 55
8.	II	0,579	0,363	1,5	1,3	6 VIII 55
9.	IV	1,066	0,431	2,4	1,2	13 VIII 55
10.	IV	1,080	0,431	2,5	1,4	13 VIII 55
11.	IV	1,090	0,442	2,4	1,5	13 VIII 55
12.	IV	0,945	0,488	2	1,2	13 VIII 55

ctd. Table XXIV

13.	V	1,659	0,464	3,5	1,0	19 VIII 55
14.	V	1,647	0,523	3,1	1,2	16 VIII 55
15.	V	1,550	0,545	2,8	1,1	19 VIII 55
16.	V	1,625	0,568	2,8	1,2	16 VIII 55
17.	V	1,602	0,590	2,7	1,2	16 VIII 55
18.	VI	2,197	0,590	3,7	0,7	23 VIII 55
19.	VI	2,948	0,700	4,2	0,8	23 VIII 55
20.	VI	2,840	0,769	3,6	1,0	27 VIII 55
21.	VII	3,000	0,790	3,7	1,0	1 IX 55

The nervous system of *Spilarctia lutea* Hufn. larvae is colourless, nevertheless the nervous ganglia could be seen against the light.

The brain and the suboesophageal ganglion are in the first larval instar in the prothorax. In the second and third instars, the brain is between the head and the prothorax, about half of it in the thorax; the suboesophageal ganglion and the first thoracic ganglion are in the thorax. At the fourth instar, the brain lies already in the occipital foramen and cannot be seen from above. It becomes visible, however, when the larva inclines the head. In this instar the suboesophageal ganglion is still in the prothorax. In the fifth and further instars, the brain is already in the head [Pl. LXIX, 5].

The last two ganglia in the ventral nerve cord are fused, like in the ventral nerve cord of *Coscinia cribaria* L. [Pl. LXXI, 15].

34. *Eupithecia pulchellata* Steph. of the family *Geometridae*

On July 13-th, 1954, I collected a flowering *Digitalis grandiflora* Mill. on Niedźwiedzia Góra. I found larvae from the family *Geometridae* in almost every single flower bud, and in many still unripe seed capsules; the larvae developed ultimately into *Eupithecia pulchellata* Steph. imagines.

Feeding on inner and outer parts of the inflorescence, the larvae made their way into the capsules where they fed on the seeds. At that stage of life, they may be reckoned among those feeding in fruits.

Table XXV

Eupithecia pulchellata STEPH.

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	0,250	0,217	1,1	3	16 VII 54
2.	0,363	0,307	1,1	3	15 VII 54
3.	0,381	0,270	1,4	3,4	14 VII 54
4.	0,420	0,316	1,3	3	15 VII 54
5.	0,431	0,307	1,4	3,4	15 VII 54
6.	0,568	0,363	1,5	2	15 VII 54
7.	0,624	0,318	2	2,3	16 VII 54
8.	0,635	0,318	2	2,3	13 VII 54
9.	0,835	0,400	2	2,8	2 VII 54
10.	0,871	0,431	2	2,2	15 VII 54

The epicranial index of between 2 and 3.4, shows that caterpillars of *Eupithecia pulchellata* STEPH. have heads of the prognathous type. Nevertheless, the larvae hold their heads not horizontally, but inclined.

The brain and the suboesophageal ganglion of specimens 1—4 was in the prothorax; in specimens 5—10, the brain was partly covered by the epicranium, particularly so, almost over one half, in specimens 9 and 10. In any case, it was not inside the head. Hence, it may be said that caterpillars of *Eupithecia pulchellata* STEPH. have their brain and suboesophageal ganglia throughout their life time outside their heads.

35. *Bupalus piniarius* L. of the family *Geometridae*

[Fig. 2a]

A larva hatched from an egg, found on a pine at Krzeszowice on July 7-th, 1955, had on the second day of life the following dimensions:

Width of the head — 0.450 mm; Width of the brain — 0,280 mm; Cer. i. — 1,6;Ep. i. — 0,5.

The brain and suboesophageal ganglion was in the head. In an other specimen, which was 4 days old, the situation was similar.

36. *Thyatira batis* L. of the family *Cymathophoridae*

I found the larvae on the surface of the leaves of *Rubus idaeus* L.

Table XXVI

Thyatira batis L.

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date	Locality
1.	2,787	0,512	5,4	1,1	21 VIII 54	Tenczynek
2.	2,948	0,624	4,7	0,5	27 VII 54	Niedźwiedzia Góra
3.	3,270	0,568	5,6	0,7	25 VIII 54	Tenczynek

The brain and suboesophageal ganglion of all three specimens was hidden deep in the head.

37. *Cosmia fulvago* L. of the family *Noctuidae*

In the catkins of the sallow willow (*Salix caprea* L.), I found in April 1955 several young larvae of *Cosmia fulvago* L., which ultimately developed into imagines in July. I took the measurements of one of the larvae without destroying it, so that I could continue its rearing.

Width of the head — 0,790 mm; Width of the brain — 0,340 mm; Cer. i. — 2,3; Ep. i. — 1,8,

Three quarters of the brain were in the prothorax.

38. *Cuculia verbasci* L. of the family *Noctuidae*

I examined only two specimens, one from a *Verbascum sp.* and another, slightly older one, from *Scrophularia nodosa* L.

1. Width of the head — 2,224 mm; Width of the brain — 0,488 mm; Cer. i. — 4,5; Ep. i. ?.
2. Width of the head — 3.698 mm; Width of the brain — 0,790 mm; Cer. i. — 4,8; Ep. i. — 1.

The head of the larvae was orthognathous, with a convex epicranium. The brain was in the head and the suboesophageal ganglion could be noticed in the occipital foramen. The nerve ganglia were of a rusty colour.

39. *Cuculia lactucae* SCHIFF. of the family *Noctuidae*

I found only one larva on Niedźwiedzia Góra, on the same site, where I collected the two of the species mentioned before, but on *Mycelis muralis* (L.) DUM., on July 27-th, 1954.

Width of the head — 2,492 mm; Width of the brain — 0,624 mm; Cer. i. 4, Ep. i. 0,6.

Position of the brain and suboesophageal ganglion was like in the species referred to before.

40. *Polia pisi* L. of the family *Noctuidae*

I found three larvae, all on low plants.

Table XXVII

Polia pisi L.

No.	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date	Locality
1.	2,358	0,590	3,9	0,8	17 VIII 54	Tenczynek
2.	2,948	0,657	4,4	0,9	5 IX 54	Niedźwiedzia Góra
3.	3,484	0,735	4,7	0,9	5 IX 54	,, ,,

The heads of all three were of the prognathous type. The nervous ganglia were colourless, the brain and the suboesophageal ganglion was hidden deep in the head.

41. *Polia persicariae* L. of the family *Noctuidae*

On September 3-d, 1954, I collected one specimen from *Polygonum persicaria* L. on Niedźwiedzia Góra.

Width of the head — 3,055 mm; Width of the brain — 0,679 mm; Cer. i. — 4.4; Ep. i. — 1,1.

The brain was deep in the head.

42. *Acronycta rumicis* L. of the family *Noctuidae*

One specimen found on Niedźwiedzia Góra.

Width of the head — 2,626 mm; Width of the brain — 0,624 mm; Cer. i. — 4,2; Ep. i. -- 1,2.

The head was of the orthognathous type. Cerebral ganglia were in the head.

43. *Drepana lacertinaria* L. of the family *Drepanidae*

Only one specimen was examined with reference to the nervous system.

Width of the head — 2,331 mm; Width of the brain — 0,557 mm; Cer. i. — 4,0; Ep. i. — 0,6.

The brain was inside the head which was of the orthognathous type.

44. *Dendrolimus pini* L. of the family *Lasiocampidae*

I collected the eggs of this species from the trunk of a pine on Niedźwiedzia Góra on July 30-th, 1953. The larvae hatched on August 4-th, 1953. I examined one specimen.

Width of the head — 2,117 mm; Width of the brain — 0.624 mm; Cer. i. — 3,3; Ep. i. —0,6, third instar.

The head was of the prognathous type with the brain lying deep inside.

45. *Lymantria dispar* L. of the family *Lymantriidae*

I examined one larva which I found on the trunk of a beech-tree on July 7-th, 1954.

Width of the head — 3,484 mm; Width of the brain — 0,660 mm; Cer. i. — 5,2; Ep. i. — 0.4.

The cephalic ganglia were in the head which was of the orthognathous type.

46. *Phalera bucephala* L. of the family *Notodontidae*

The larvae hatched on July 22-nd from eggs found on *Populus tremula* L. One of them, examined in the first day of life, had the following measurements:

Width of the head — 0,657 mm; Width of the brain — 0,295 mm; Cer. i. — 2,3; Ep. i. — 0,5.

The dimensions of two older ones were as follows:

Width of the head — 1,220 mm; Width of the brain — 0,452 mm; Cer. i. — 2,7; Ep. i. — 0,5; August22-nd, 1954.

Width of the head — 3,108 mm; Width of the brain — 0,545 mm; Cer. i. — 5,7; Ep. i. — 0,43.

Beginning with the first instar, all had the brain and the suboesophageal ganglion in the head.

47. *Dicranula vinula* L. of the family *Notodontidae*

The larvae hatched on July 24-th, 1954, from eggs collected on July 21-st at Tenczynek. One of the specimens was examined.

Width of the head — 0,712 mm; Width of the brain — 0,307 mm; Cer. i. — 1,8; Ep. i. — 1.

In addition, the measurements of an older larva were taken.

Width of the head — 2,412 mm; Width of the brain — 0,409 mm; Cer. i. — 5; Ep. i. — 0,35.

The cephalic ganglia of both specimens were in the head.

48. *Pheosia tremulae* Cl. of the family *Notodontidae*

The larvae hatched on August 29-th, 1955, from eggs deposited on August 23-rd, 1955. One of the larvae was examined in its second day of life, and the dimensions found were as follows:

Width of the head — 0,735 mm; Width of the brain — 0,284 mm; Cer. i. — 2,5; Ep. i. — 0,7.

The cephalic ganglia of the specimen were in the head.

49. *Lophopteryx camelina* L. of the family *Notodontidae*

I collected the larva on July 24-th, 1954, from *Crataegus monogyna* Jacq. on Niedźwiedzia Góra.

Width of the head — 3,645 mm; Width of the brain — 0,613 mm; Cer. i. — 5,9; Ep. i. — 0,5.

The cephalic ganglia were inside the head.

50. *Celerio euphorbiae* L. of the family *Sphingidae*

One specimen was examined.

Width of the head — 4,020 mm; Width of the brain — 0,956 mm; Cer. i. — 4,2, Ep. i. — 0.4; August 15-th, 1954

Both cephalic ganglia were in the head.

51. *Sphinx pinastri* L. of the family *Sphingidae*

The larva was collected at Tenczynek on July 17-th, 1954.

Width of the head — 5,360 mm; Width of the brain — 0,990 mm; Cer. i. — 5,4; Ep. i. — 0,35.

Both cephalic ganglia were in the head.

52. *Araschnia levana* L. of the family *Nymphalidae*

I collected the larva used in examinations in various environments of Krzeszowice. They were the progeny of the gen. *aestiva prorsa* L.

Table XXVIII

Araschnia levana L.

No.	Instar	Width of the head in mm	Width of the brain in mm	Cer. i.	Ep. i.	Date
1.	I	0,442	0,363	1,2	1,1	21 VIII 54
2.	II beginning	0,657	0,284	2,3	1	23 VIII 54
3.	II end	0,624	0,363	1,7	1,4	22 VIII 54
4.	IV	0,933	0,500	1,8	0,8	24 VIII 54
5.	?	2,260	0,700	3,2	1	,,

The larvae of *Araschnia levana* gen. *aestiva prorsa* L. have a head of an intermediate, i. e., orthognatho-prognathous type and hold it in a vertical position. Already beginning with the first instar, the skin is opaque; the nervous system is colourless and not discernible in living specimens. It is worthy of interest that, in agreement with their relatively small cerebral index in the first instar, their brain and suboesophageal ganglion are in the prothorax. In the instars from II to IV, the brain lies in the occipital foramen; in the second instar, it is slightly tilted into the prothorax. In the fifth specimen, it was together with the suboesophageal ganglion somewhat deeper in the head than in specimens 2—4.

The cerebral indices, quoted in Table XXVIII, are merely approximate, since the measurements were taken under adverse conditions. While the head was prepared, both cerebral hemispheres, lying beside one another in the head, separated as if there was no commissure between them. The width of the brain had to be calculated from the width of one hemisphere, which could not afford absolutely exact results. Of all the material I used in my studies on the topography of the central nervous system of larvae, this was the only case in which the cerebral hemispheres separated in the course of preparation.

53. *Vanessa urticae* L. of the family *Nymphalidae*

The cephalic ganglia of the larvae which I collected on August 26-th, 1953, were in the head. No measurements were taken.

54. *Vanessa io* L. of the family *Nymphalidae*

I examined two larvae of the species.

Width of the head — 2,486 mm; Width of the brain — 0,832 mm; Cer. i. — 3; Ep. i. — 0,5; July 22-nd, 1954.

Width of the head — 2,716 mm; Width of the brain — 1,021 mm; Cer. i. — 2,6; Ep. i. — ?; August 26-th, 1953.

The cephalic ganglia of both specimens were in the head.

55. *Gonepteryx rhamni* L. of the family *Pieridae*

I examined the smallest one of the material collected on June 25-th, 1955, on leaves of *Frangula alnus* Mill.

Width of the head — 0,922 mm; Width of the brain — 0,431 mm; Cer. i. — 2,1; Ep. i. — 1.

56. *Pieris rapae* L. of the family *Pieridae*

I examined two one-day-old specimens.

Width of the head — 0,442 mm; Width of the brain — 0,273 mm; Cer. i. — 1,6; Ep. i. — 1; July 27-th, 1954.

Width of the head — 0.396 mm; Width of the brain — 0,261 mm. Cer. i. — 1,4; Ep. i. — 11; July 27-th, 1954.

Part of the brain was in both larvae outside the head, in the prothorax. It may be said that it was on the border between the prothorax and the occipital foramen.

57. *Pieris brassicae* L. of the family *Pieridae*

Only one specimen was prepared.

Width of the head — 3,430 mm; Width of the brain — 0,891 mm; Cer. i. — 3,8; Ep. i. — 1; August 26-th, 1953.

The cephalic ganglia were colourless and lay in the head.

SUMMING UP OF THE RESULTS

A. Position of the cephalic nervous ganglia

The studies on the topography of the central nervous system of caterpillars have made me to distinguish three categories on that evidence:

in category I, I include caterpillars whose cephalic ganglia are in the thorax throughout all their life [Pl. LXVIII];

in category II, I include caterpillars whose cephalic ganglia are initially in the thorax, and towards the end of development in the occipital foramen, or deeper inside the head;

category III comprises caterpillars whose cephalic ganglia are in the head, beginning with the first day of their life.

It might be assumed that, in order to include a larva in one of the categories referred to before, knowledge of the position of the brain in the body in all instars is indispensable. This, however, is neither always possible, nor always necessary, since any larva having brain and suboesophageal ganglion in the thorax in the last instar has them in the thorax also throughout all the preceding stages of development. Consequently, we may include in category I, any species whose ultimate larval instars are found to have the brain in the thorax.

However, a larva with the brain inside the head in the final instar cannot be classed, merely on that evidence, either in the second or in the third categories, since such a position is characteristic for both categories. In this case, it is necessary to examine the position of the ganglia at least over the last few instars, as had to be done frequently in the course of the work under report. If, on the other hand, a larva is found to have the brain in the head beginning with the first stage of life, it has to be included in category III, for here holds the second generalization: if the brain is in the head of a larva in, e. g., the first life stage it is there also throughout all the subsequent stages.

Caterpillars of category I.

Of the species I examined, I include in the first category the following ones:

I. *Eriocraniidae*:	1. *Allochapmannia semipurpurella* STEPH. *
II. *Nepticulidae*:	2. *Nepticula basalella* HS, *turicella* HS, *argentipedella* Z., *rhamnella* HS., *fragariella* HEYD., *septembrella* STT., *centifoliella* Z., *aucupariae* FREY, *oxyacanthella* STT., *myrtillella* STT.
III. *Incurvariidae*:	3. *Incurvaria oehlmaniella* TR., *muscalella* F.
IV. *Leucopterygidae*:	4. *Leucoptera lustratella* HS. and *wailesella* STT.
V. *Lyonetiidae*:	5. *Lyonetia clerkella* L.
VI. *Tischeriidae*:	6. *Tischeria complanella* HBN.
VII. *Bucculatrigidae*:	7. *Bucculatrix frangulella* GOEZE, *crataegi* Z. *
VIII. *Gracilariidae*:	8. *Xanthospilapteryx syringella* F.
	9. *Euspilapteryx auroguttella* STEPH.
	10. *Lithocolletis oxyacanthae* FREY, *sorbi* FREY.
IX. *Coleophoridae*:	11. *Coleophora vacciniella* HS, *fuscedinella* Z. *virgaureae* STT. *, *gryphipennella* BOUCHÉ *, *laricella* HBN. *
X. *Hyponomeutidae*:	12. *Ocnerostoma piniariella* Z. *
	13. *Argyresthia coniugella* Z.
	14. *Rösslerstamia erxlebella* F.
XI. *Elachistidae*:	15. *Dyselachista herrichiella* HS.
XII. *Heliozelidae*:	16. *Antispila pfeifferella* HBN., *stachjanella* DZ., *petryi* MART.
XIII. *Momphidae*:	17. *Lophoptilus raschkiellus* Z.
XIV. *Gelechiidae*:	18. *Chrysopora hermannella* F. *, *stipella* HBN. *
XV. *Tortricidae*:	19. *Evetria resinella* L. *
XVI. *Geometridae*:	20. *Eupithecia pulchellata* STEPH. *

Most of the species quoted, were dealt with in my previous paper on the topography of the central nervous system of caterpillars. Those recently examined are marked with an asterisk.

It follows from the specification that category I includes species whose larvae feed mostly in leaves, and only as an exception in stems and buds (*Evetria resinella* L.), or in flower buds and fruits (*Eupithecia pulchellata* STEPH.). The list includes no species whose larvae would not feed inside plant tissues over at least one life stage. There are relatively few of such temporary miners. They include:

Incurvaria oehlmanniella Tr., *muscalella* F., *Bucculatrix frangulella* Goeze and *crataegi* Z., *Xanthospilapteryx syringella* Z., *Euspilapteryx auroguttella* Steph. and *Rösslerstamia erxlebella* F.

The remaining ones belong to those mining throughout all the larval stages. Exceptionally, the larvae of *Eupithecia pulchellata* Steph. live in the first stages of life in flower buds, and not inside plant tissues.

Caterpillars of category II.

I include in category II the following of the species examined:

I. *Hyponomeutidae*:	1. *Hyponomeuta malinellus* Z.
II. *Oecophoridae*:	2. *Chimabacche fagella* F.
III. *Gelechiidae*:	3. *Gelechia malvella* Hbn.
IV. *Tortricidae*:	4. *Laspeyresia pomonella* L.
	5. *Cacoecia piceana* L.
V. *Pyralidae*:	6. *Sylepta ruralis* Sc.
	7. *Eurrhypara urticata* L.
	8. *Ephestia kühniella* Z.
	9. *Homoeosoma nimbella* Z.
VI. *Psychidae*:	10. *Canephora unicolor* Hufn. and probably other species of the family
VII. *Zygaenidae*:	11. *Zygaena ephialtes* var. *peucedani* Esp. and probably other species of the genus *Zygaena* F. It is unknown, however, whether *Procris statices* L. is also included.
VIII. *Arctiidae*:	12. *Coscinia cribraria* L.
	13. *Spilarctia lutea* Hufn.
IX. *Noctuidae*:	14. *Cosmia fulvago* L.

Of all the species quoted, only *Hyponomeuta malinellus* Z. and *Cacoecia piceana* L. feed in their youth inside leaves. On the other hand, *Gelechia malvella* Hbn., *Homoeosoma nimbella* Z. and *Laspeyresia pomonella* L., mine inside fruits or seeds of plants. Whether *Laspeyresia grossana* Hw. ought to be put here too remains yet to be decided. *Ephestia kühniella* Z. feeds in flour, burried in vegetable material but not in tissues. *Cosmia fulvago* L. seeks food over a longer space of time in the catkins of the sallow willow (*Salix caprea* L.). I put it in category II, since it may be assumed to have the brain in the head towards the end of its life.

The remaining larvae feed on the surface of plants, though under slightly different conditions than larvae of category III. Towards the end of their larval life, their brain is also in the head or in the occipital foramen.

The larvae of *Araschnia levana* L. represent a borderline case between the categories II and III; in shape of body and head, they are close to the larvae of category III while the position of the brain in their first instar puts them closer to the larvae of category II.

Caterpillars of category III.

Of the species examined, I put in category III all those included in the list on page 10—12, beginning with the family *Geometridae* and ending with *Pieridae*; exceptions are: *Eupithecia pulchellata* Steph., which had to be put in category I, and *Araschnia levana* L. whose place is on the borderline between categories II and III. Consequently, I include in category III most of the species popularly termed „*Macrolepidoptera*".

Their position in category III is determined by the location of the cephalic ganglia in their first larval instar. Thus, it follows that it is necessary to examine the topography of the cephalic ganglia in this early life stage of the larvae considered. Unfortunately, this is not always possible, since it calls for rearing the larvae from eggs. I had an opportunity to start such rearing with regard to the following species: *Phalera bucephala* L., *Dicranula vinula* L., *Pheosia tremula* Cl., *Pieris rapae* L.

The remaining species included in category III were examined in later instars. Nevertheless, I do not hesitate to include also these species in category III. That I am justified in doing so is confirmed, as I think, by the structure of the head, which will be dealt with further below. Furthermore, the view is based also on the research work of Brandt (1879, 2). His research work, which dealt also with the topography of the central nervous system of caterpillars, involved on the whole genera and, partly, even the same species which I included in category III. Brandt found that the cephalic ganglia of all of them were in the head. Hence, my studies relating to this group of caterpillars were not as extensive as those relating to categories I and II. They were mainly intended to check up on the results of BRANDT'S work.

B. Relation between the structure of the head and the position of cephalic ganglia in larvae

a. The larvae belonging into Category I, i. e., those having cephalic ganglia throughout their life-time in the thorax, have heads of the prognathous type. In some of them, there is no sutura coronalis, which makes it thus impossible to calculate the epicranial index. In others, the sutura coronalis is so short in relation to the height of the clypeus, that the epicranial index is greater than 2, attaining, exceptionally even exceeding, 4. Further below I quote examples of mean values of the epicranial index relating to the larvae of several species belonging to various categories.

Table XXIX

Mean epicranial index values for the caterpillars belonging to various categories

Categ.	No.	Name of the species	Ep. i.
I	1.	*Ocnerostoma piniariella* Z.	2,4 in instar III
	2.	*Coleophora laricella* HBN.	2,7
	3.	*Evetria resinella* L.	3,4
	4.	*Chrysopora stipella* HBN.	4
II	5.	*Cacoecia piceana* L.	2
	6.	*Hyponomeuta malinellus* Z.	1,3
	7.	*Zygaena ephialtes* v. *peucedani* ESP.	1,3
	8.	*Spilarctia lutea* HUFN.	1,2
III	9.	*Thyatira batis* L.	0,7
	10.	*Polia pisi* L.	0,9
	11.	*Phalera bucephala* L.	0,5
	12.	*Sphinx pinastri* L.	0,3

It happens occasionally that the first larval instars of some species belonging into category I, have no sutura coronalis but that it appears in later instars. Such species are exemplified, for instance, by *Bucculatrix frangulella* Goeze — mining in the first two instars the leaves of *Frangula alnus* Mill., or *Rhamnus cathartica* L. — and *Ocnerostoma piniariella* Z. feeding in the leaves of *Pinus silvestris* L.

b. Most of the caterpillars belonging into category II, i. e., of those having the brain in the thorax in the early stages of life, and in the head in the final larval instars, have a head of the prognathous type and hold it in a horizontal position. The minority have a head which is intermediate between the prognathous and the orthognathous types. As compared with the species of category I, their epicranial index is on the whole smaller; it rarely attains 2, but is larger than 1. In this respect *Ephestia kühniella* Z. represents an exception, its epicranial index being 3 in the first instar and slightly larger than 2 towards the end of larval life.

c. Caterpillars belonging into category III, i. e., those whose brain is in the head beginning with the first stage of life, have heads of the orthognathous type and hold it more or less vertically. As compared to species in categories I and II, their epicranial index is much smaller, rarely attaining 1, and as a rule represented by a fraction. Owing to the pronounced convexity of the epicranium, the sutura coronalis is not rectilinear but curved. Differences in the structure of the head, as between larvae of categories I and II on the one hand, and those belonging into category III on the other, involve also the size of the occipital foramen. In larvae of the categories I and II the diameter of this aperture equals the diameter of the head (the pantotremic head according to Weber (1933), while it is slightly smaller inl arvae belonging to category III.

It follows from the observations referred to before that there is a distinct relation between the structure of the head and the location of the cephalic ganglia. This becomes evident in table XXX, presented below.

Do the structure of the head and the epicranial index

Table XXX

Relation between the structure of the head and the position of the brain in the body of larvae

Category of larvae	Structure of the head	Ep. i.	Position of the brain in the body	
			in young specimen	towards end of life
I	prognathous	incalculable or more than 2	in the thorax	in the thorax
II	prognathous or prognatho-orthognathous	more than 1 less than 2	in the thorax	in the head
III	orthognathus	less than 1	in the head	in the head

warrant any conclusions as to the position of cerebral ganglia in the body of a larva?

It appears to me that even today, we may agree on the following generalizations: 1. When a caterpillar has a head of the prognathous type with no sutura coronalis, or a short one only, and with an epicranial index that cannot be calculated, or is larger than 2, it may be assumed beforehand that the nervous ganglia are in the thorax. They remain there in all larval instars.

2. When a caterpillar has a head of the prognathous type with an epicranial index larger than 1 and less than 2, it may be assumed with great likelihood that the cephalic ganglia are in the thorax during the first larval stages.

3. When, however, a caterpillar has a head of the orthognathous type, and an epicranial index represented by a fraction, it may be assumed with all certainty that its cephalic ganglia are in the head throughout the entire larval life.

M. BEIER (1928) remarked in his work on the central nervous system of larvae of *Coleoptera*, that there are differences not only in the position of the ganglia of the ventral nerve cord, but also in that of cephalic ganglia. He mentions also that the pronounced development of masticatory muscles may involve a complete (*Cantharis rustica* FALL.) or partial (certain

Cerambycidae, *Coccinellidae*, *Dryopidae*) shift of the brain, and a complete shift of the suboesophageal ganglion (*Dermestidae*, *Chrysomelidae*, *Coccinellidae*, *Dryopidae*, *Silphidae* and *Tenebrionidae*) into the prothorax.

Thus, M. Beier relates the shifting of the cephalic ganglia to the development of the masticatory muscles. I think that, with regard to lepidopterous larvae with heads of the prognathous type, the shifting of the cephalic ganglia into the thorax may be attributed to similar causes. This type of head, as compared to the orthognathous type, has substantially shorter posterior parts, is occasionally considerably flattened, and sometimes so small, in relation to the size of the brain, that simultaneous accommodation of both masticatory muscles and nervous ganglia is frequently simply out of question [Fig. 2b, Plate LXX, 7 and 11, Plate LXXI, 16].

In order to present a more complete picture of the relation existing between the shifting of nervous ganglia and the structure of the head, we have to consider also the cerebral index.

As has been mentioned before, this index grows slowly with the progressing development of the larva. It is smallest in the first life stage, and largest in the last one. This is shown in table XXXI, with regard to larvae of the first and second categories. At the first life stage the brain of larvae of category I, occasionally also of category II, is about the width of the head, or but slightly smaller. Hence, the cerebral index is 1, or slightly more. The larvae of *Bucculatrix frangulella* Goeze and *Ocnerostoma piniariella* Z. are exceptions; their brain is in the first stage of life wider than the head and, therefore, their cerebral indices are at that time 0.8 and 0.5 respectively.

Towards the end of the larval stage — owing to the fact that the head grows more rapidly than the brain (a generalization that holds for all the larvae I know) — the width of the head exceeds in larvae of category I the width of the brain twice or slightly more, so that the cerebral index is about 2, or occasionally slightly more.

With regard to larvae of category II, the cerebral index is in the first life stage on the whole somewhat less than in the case of category I; towards the end of larval life it is about 3 or somewhat more.

As regards larvae of category III, the brain is on the whole already in the first life stage considerably less in width than the head, and the cerebral index is therefore about 2, attaining towards the end of life 5, or even more, as, for instance, in the case of *Phalera bucephala* L.

Table XXXI

Mean value of the cerebral index of caterpillars in various instars

Category I

No.	Name of species	Instars					
		I.	II.	III.	IV.	V.	VI.
1.	*Incurvaria oehlmanniella* Tr.	1,4	1,3			2,1	2,4
2.	*Incurvaria muscalella* F.		1,4	1,8	1,9		2,2
3.	*Leucoptera lustratella* Hs.	1	1,5	1,5	2	—	—
4.	*Bucculatrix frangulella* Goeze	0,8	1,1			1,2	
5.	*Ocnerostoma piniariella* Z.	0,5	1,2	1,3		—	—
6.	*Chrysopora stipella* Hbn.		1,2	1,3	1,8	—	—
7.	*Evetria resinella* L.		1,5	1,7	2,1	2,1	

Category II

No.	Name of species	Instars					
		I.	II.	III.	IV.	V.	ultimate
1.	*Ephestia kühniella* Z.	1,2	1,2	1,4			2,7
2.	*Canephora unicolor* Hufn.	1,2	1,6	2,2	2,5		3,9
3.	*Zagaena ephialtes* var. *peucedani* Esp.	1,4	1,6	1,7			
4.	*Coscinia cribraria* L.	1,1	1,5	1,6	2		
5.	*Spilarctia lutea* Hufn.	1,3	1,6		2,3	3	3,7

Empty spaces in the table denote that no measurements were taken in the given instar. A dash signifies that the given larval instar does not exist.

The relation referred to before, existing between the cerebral index, age, and head structure of a larva, may be helpful in judging the age of a specimen found in the field. Several examples are quoted below.

On September 14-th, 1954, I found in the fruit of *Solidago virgaurea* L. an unknown larva with a head of the prognathous type, and a cerebral index of 1. The value of the index suggested that the larva was in the first instar. It turned out later on that the larva in question belonged to the species *Coleophora virgaureae* Stt., and was in fact in the first instar.

The larvae of *Talaeporia tubulosa* Retz., found in September, had a cerebral index between 2 and 2.3, a prognathous head and an epicranial index of 2.2. I took this to indicate that I was dealing with larvae far advanced in development. Some time later, I found that larvae of *Talaeporia tubulosa* Retz. about to conclude their development, have in fact a cerebral index of about 2.

C. Relation between the environment in which larvae feed and the shifting of cephalic ganglia

Having discussed the relation existing between the prognathous structure of the head and the shifting of cephalic ganglia, we have to deal with the relation between the shifting of the ganglia and the environment in which the larvae feed, or live.

I could not solve the problem in my first paper, dealing with the topography of the central nervous system of mining larvae of *Tineoidea*, since my studies were restricted to only one superfamily. Presently, having learned the relations existing in larvae belonging to various superfamilies, I have reached the following general conclusions:

a. Of all the larvae I know, those feeding throughout their life-time inside leaves have not only a prognathous type of head, which is characteristic for them, but they have also cephalic ganglia throughout their life time in the thorax. It ought to be stressed that, within this group of larvae, the shifting of cephalic ganglia into the thorax is most pronounced [Plate LXVIII, 1, and Plate LXX, 7].

b. A large majority of the larvae I know, that are feeding inside leaves in one, or several, of the first instars, have like group „a“ the cephalic ganglia in the thorax throughout their entire life. *Cacoecia piceana* L. and *Hyponomeuta malinellus* Z. represent in this case the only two exception I know, since towards the end of the larval stage, their brain is in the head, I assume, however, that in future we shall know more such exceptions.

c. Not only larvae mining in leaves, but all those I know that are feeding in stems, buds, fruits and seeds, have their cephalic ganglia shifted into the prothorax throughout the larval stage, or over several of the first stages of life [Plate LXX, 9].

According to Brandt (1879, 2), the brain and suboesophageal ganglion of larvae of *Cossus cossus* L., which feed inside the trunks of deciduous trees, are in the head. This detail of the topography of the nervous system in larvae of *Cossus cossus* L. contradicts my generalization „c“. This fact alone was sufficient as a reason for reëxamining the problem. Unfortunately, I had no opportunity to obtain the necessary material. Nevertheless, it seems to me that the larva of *Cossus cossus* L., which has a prognathous head, an epicranial index of 2 as reported by Ripper (1929) and feeds in wood, will not prove an exception. Most likely, the brain is in the thorax at least in the early stages of development, similarly to the larvae of category II.

d. Two groups may be distinguished among caterpillars feeding freely on the surface of plants, i. e., among those that are not mining.

1. The group in which the cephalic ganglia are during the first few life stages in the prothorax, and during the subsequent ones in the head, that is, similarly as in the larvae of category c [Plate LXX, 6, 11].

2. The group in which the ganglia are in the head, beginning with the first day of life.

Group d1 includes the following of the species I examined: *Chimabacche fagella* F., *Sylepta ruralis* Sc., *Eurrhypara urticata* L., *Ephestia kühniella* Z., *Canephora unicolor* Hufn. and probably also others of the family *Psychidae*; of the *Zygaenidae* — the genus *Zygaena* F. of the *Arctiidae* — *Arctia caja* L., *Coscinia* *cribraria* L., and *Spilarctia lutea* Hufn. [Plate LXIX, 5], and also *Araschnia levana* L.

In group d2, I reckon the other „*Macrolepidoptera*" mentioned in the work.

If, in the world surrounding us, there were merely larvae of groups a, b, c and d2, it could be assumed, I think, that prognathism developed in groups a, b and c in result of the mode of feeding inside plant tissues, and was, in turn, responsible for the shifting of cephalic ganglia into the thorax.

However, in reality, prognathism as well as the shifting of cephalic ganglia may be revealed in a certain, by no means inconsiderable number of larvae living on the surface of plants.

In addition to *Talaeporia tubulosa* Retz. and *Ephestia kühniella* Z. I wrote about in my first paper (1957), still other no less significant examples may be found.

The larvae of *Eurrhypara urticata* L., feeding in spun together tips of shoots of *Urtica dioica* L., and not in mines, have prognathous heads, and their cephalic ganglia are during the first stages of life in the thorax. The case of larvae of *Chimabacche fagella* F. is similar. In July 1954, I found larvae of an unknown species in perfect flower buds, and later, in August, in unripe seed capsules of *Hypericum perforatum* L., collected in the environments of Krzeszowice. The larvae had prognathous heads, and cephalic ganglia were in the thorax, although they were not mining.

The head of *Eupithecia pulchellata* Steph., of the family *Geometridae*, is prognathous in all the larval instars, and the cephalic ganglia are in the thorax. I found the first larval instars of the species inside flower buds of *Digitalis grandiflora* Mill. where they fed, without mining, on parts of the flower.

I found larvae of the species *Cosmia fulvago* L. in the staminate catkins of the sallow willow (*Salix caprea* L.) between the flowers, and not in mines. They were well advanced in their development; their heads were prognathous and their brains, in the prothorax. Still other larvae possessing prognathous, or prognatho-orthognathous heads and with the brain in the prothorax, may be found among those feeding freely on the surface of plants. They belong to the families *Psychidae*, *Zygaenidae* and *Arctiidae*.

Hence, it seems to me, that the shifting of cephalic ganglia into the thorax, observed in some caterpillars, cannot be linked merely with endophagism. It would be more justified to link it with the mode of life of certain caterpillars which live in narrow spaces. The number of exceptions referred to above would then be less.

Thus, it may be said, for instance, that the larvae of *Talaeporia tubulosa* RETZ., as well as those of species from the family *Psychidae*, though feeding all their life on the surface of plants, nevertheless travel over the latter in cases. Consequently, they live in a narrow space, similar to that enclosing larvae feeding in leaves, buds and stems.

The larvae of *Chimabacche fagella* F. do not drive mines in the tissues of leaves, nor do they live in cases like, for instance, the *Psychidae*, but they generally connect leaves face to face and live between them in a narrow space resembling a cavernous mine. As regards *Ephestia kühniella* Z., the larvae of this species live in flour, surrounded by material of plant origin. The larvae of *Eupithecia pulchellata* STEPH., on the other hand, feed initially in the spacious caverns of buds of *Digitalis grandiflora* MILL. and, subsequently, in seed capsules devoid of caverns.

Thus, assuming an effect of the mode of life in narrow spaces on the shifting of cephalic ganglia into the thorax, the number of exceptions is restricted, but they are not eliminated altogether and the following cases still remain: the larvae of *Cosmia fulvago* L., which have a prognathous head, feed in the early stages exclusively between the flowers of *Salix caprea* L. and, subsequently, freely on the surface of leaves. Larvae of the genus *Zygaena* F., also *Arctia caja* L. and *Spilarctia lutea* HUFN., spend the entire life on the surface of plants, and their cephalic ganglia are in the first stages of life in the thorax.

It appears that the exceptions are few. I assume, however, that with time it will be possible to report many more. Of the *Noctuidae* alone there are 431 species quoted by J. ROMANISZYN (1929) for Poland, whereas I was able to take into account merely 6 of them. For two families only, the *Pyralidae* and the *Tortricidae*, Fr. SCHILLE (1930) quotes 678 species, of which I was able to consider merely 8. Writing on *Tortricidae*, Kennel (1921) reports that their larvae have prognathous heads like the mining ones, and that they can partly retract the head into the prothorax. The two families are most likely to include enough of such species whose larvae, though feeding on the surface of plants, have heads of the prognathous type and nervous ganglia shifted into the thorax, at least in the early stages of life.

This is the weak point of conjectures linking the shifting of nervous ganglia exclusively with the life of larvae in narrow spaces.

SHIFTS WITHIN THE VENTRAL NERVE CORD

Almost all information included in section IV are based on observations in vivo. The observations were concerned with the position and the tracheation of ganglia in entirely quiescent larvae submerged in water without the use of anaesthesia, since the latter caused the body to shrink and, consequently, the ganglia to shift. Removal and preparation of the ganglia also yielded unreliable results. Therefore, I took into account only such forms in which the necessary details could be observed without destruction of the specimen.

Only the with, length of abdominal ganglia and course of peripheral nerves were determined on the whole in vitro.

According to Brandt (1879, 1, 2), as well as to Snodgrass (1935), Weber (1933) the ventral nerve cord of caterpillars contains three thoracic and seven abdominal ganglions. They are all single, since they all developed from a single primitive pair of fused ganglia. Only the last one, i. e., the seventh abdominal ganglion, is complex, since it results from the fusing of two pairs of primitive ganglia. It has a wider scope of functions than any of the preceding ganglia, since it supplies, in addition to the seventh segment, also the remaining abdominal ones that are destitute of ganglia.

The only exception in this rule represents according to Brandt (1879) the larva of *Cossus cossus* L., which has eight and not seven ganglia in the abdomen.

This then would be the synthesis of the part of BRANDT'S work dealing with the problem. The work of BRANDT had an extensive basis, since it was founded on examinations of 42 lepidopterous species. However, the species involved belonged almost exclusively into the „*Macrolepidoptera*“, which should not come as a surprise, since the work of BRANDT was published in 1879. Nevertheless, it is exactly this group of larvae, included in category III referred to before, which have the brain and the suboesophageal ganglion in the head, and, in agreement with BRANDT'S description, 7 nervous ganglia in the abdomen.

My observations concerned a somewhat different material involving to a considerable degree larvae of the „*Macrolepidoptera*“, and demonstrated that not only *Cossus cossus* L., but also a large number of other caterpillars have not 7 but 8 free abdominal ganglia in the abdominal nerve cord.

The position of the ganglia of the ventral nerve cord may vary. In relation with the shifting of the suboesophageal ganglion into the prothorax, also the first thoracic ganglion of larvae of categories I and II is seen to be shifted backwards. The first thoracic ganglion of larvae of category III lies more or less in the centre of the prothorax, whereas in larvae of categories I and II it is pushed further back owing to the shifting of the suboesophageal ganglion into the prothorax.

The following three alternatives can be distinguished:

1. The first thoracic ganglion is in the posterior portion of the prothorax, immediately behind the suboesophageal ganglion. This is the situation, e. g., in *Nepticula basalella* HS, *Evetria resinella* L., *Fumea casta* PALL., *Zygaena* F., *Eupithecia pulchellata* STEPH.

2. The first thoracic ganglion lies between the prothorax and the mesothorax as, for instance, in *Nepticula septembrella* STT., *Ocnerostoma piniarella* Z. and *Leucoptera lustratella* HS.

3. The first thoracic ganglion lies together with the second one in the mesothorax, as, for instance, in *Nepticula myrtilella* STT., *Bucculatrix frangulella* GOEZE, *Coleophora laricella* HBN. and *Ephestia kühniella* Z.

Behind the third thoracic ganglion there are 7 or 8 abdominal ganglia. In this part of the nervous system of caterpillars, a kind of tendency towards concentration of the system may be noted. Here, I have in mind the position of the first and the last abdominal ganglia.

In the most primitive case the first abdominal ganglion lies normally in the first abdominal segment, as, for instance, in *Incurvaria muscalella* F., *I. oehlmaniella* Tr., *Homoeosoma nimbella* Z. and *Hyponomeuta malinellus* Z. It happens, however, fairly frequently that the first abdominal ganglion lies between the metathorax and the first abdominal segment, distinctly shifted towards the front. This is, for instance, the case in *Nepticula turicella* HS., *N. basalella* HS., *N. septembrella* Stt., *N. argentipedella* Z., *Bucculatrix frangulella* Goeze, *Gelechia malvella* Hbn., *Cacoecia piceana* L., *Procris statices* L. The shift is occasionally still more distinct and involves a complete transfer into the metathorax. In such cases, the first abdominal ganglion, linked by short connectives with the third thoracic ganglion, lies together with the latter in the metathorax. This applies, e. g., to *Talaeporia tubulosa* Retz., *Nepticula myrtilella* Stt., *Chrysopora hermannella* F. and *Ch. stipella* Hbn., *Canephora unicolor* Hufn., *Fumea casta* Pall, *Zygaena* F.

As referred to before, the seventh abdominal ganglion may be also the last one; it then consists of 2 pairs of primitive ganglia. It may represent also a single ganglion, but if this is the case it is invariably followed by an eighth one, which is also single.

Two groups may be distinguished among caterpillars:

1. The first group includes larvae whose seventh ganglion is distinct from the eighth one. Again, two subgroups may be distinguished in this group:

a. Ganglion 7 is linked with ganglion 8 by connectives exceeding ganglion 7 in length. This is a rare case and, indicating absence of concentration of ganglia in the abdominal nerve cord, reveals the primitiveness of the larvae in this respect. I found this condition merely in *Nepticula myrtillella* Stt., *Leucoptera lustratella* HS. and *Hyponomeuta malinellus* Z.

b. Ganglion 7 is linked with ganglion 8 by connectives shorter than ganglion 7, but easily discernible. This subgroup included fairly numerous species: *Incurvaria muscallella* F., *I. oehlmanniella* Tr., *Talaeporia tubulosa* Retz., [Pl. LXX, 9], *Nepticula septembrella* Stt., *Bucculatrix frangulella* Goeze [Pl. LXX, 10], *Coleophora vacciniella* HS., *Chimabacche fagella* F., *Gelechia malvella* Hbn., *Laspeyresia grossana* Hw., *Cacoecia piceana* L. All these species belong to the „*Macrolepidoptera*". Of the „*Macrolepidoptera*" the genus *Zygaena* F. must be reckoned in the subgroup, which indicates the primitiveness of the genus in the order of *Lepidoptera* [Pl. LXX, 8].

In subgroups „a" and „b" of group 1, the seventh ganglion of larvae supplies the seventh abdominal segment and the eighth ganglion the subsequent three segments. In relation with this fact the eighth ganglion is fairly frequently found to be enlarged. Its size is in such cases distinctly larger than that of ganglia 6 and 7. Further below, I quote measurements which were taken in vivo owing to the transparency of the skin and pigmentation of the ganglia.

Table XXXII

The size of the last three ganglia in the abdominal nerve cord in microns

No.	Name	Instar	Width of the head	Width × length of ganglia		
				6-th	7-th	8-th
1.	*Incurvaria muscalella* F.	II		67×83	90×64	112×80
2.	,,	III		77×115	76×102	93×109
3.	*Talaeporia tubulosa* Retz.	?	1032	169×284	163×240	158×295
4.	*Bucculatrix frangulella* Goeze	I		37×64	47×54	47×77
5.	*Evetria resinella* L. (Pl. LXXI, 13)	II	523	131×128	115×118	112×138
6.	*Chimabacche fagella* F.	?	2140		203×239	226×307

I found a like distinct increase in size of ganglion 8 in *Incurvaria oehlmanniella* Tr., *Coleophora vacciniella* HS., *C. la-*

ricella Hbn., *Leucoptera lustratella* HS. and *Ocnerostoma piniariella* Z. No major differences could be noted merely in *Nepticula myrtilella* Stt. and *N. septembrella* Stt., *Cacoecia piceana* L. and *Zygaena sp.*

2. In the second group, I include larvae whose ganglia 7 and 8 form a single unit. Here, I also distinguish two subgroups:

a. Ganglia 7 and 8 are united, but a trace of the site of union has remained in the form of an interganglia coarctation [Pl. LXXI, 14] or microscopic interconnective field. The following species belong into the subgroup: *Chrysopora hermanella* F., *Cacoecia piceana* L., *Cuculia verbasci* L. and *C. lactucae* L., *Polia pisi* L. and *P. persicariae* L., *Dendrolimus pini* L., *Eupithecia pulchellata* Steph., *Canephora unicolor* Hufn., *Fumea casta* Pall. [Pl. LXXI 14], *Sterhopteryx hirsutella* Hbn., *Araschnia levana* L. and *Pieris brassicae* L.

Observing ganglion 7 + 8 from the side in *Dendrolimus pini* L., as well as in three representatives of the family *Psychidae*, I established the presence of very short connectives between ganglia 7 and 8.

b. In subgroup b, I include larvae whose ganglion 7 + 8 is perfectly united without any external traces of the union. I reckon here *Ephestia kühniella* Z. [Pl. LXXI, 17], *Homoeosoma nimbella* Z., *Eurrhypara urticata* L., *Arctia caja* L.

In subgroup 2a ganglia 7 and 8 are so distinct, in spite of fusion, that both can be measured. Ganglion 8 is usually somewhat larger than ganglion 7. I recorded the relevant data in Table XXXIII.

There are cases in which the two ganglia are almost identical in size. In a larva of *Phalera bucephala* L., whose head was 3108 μ wide, ganglion 7 was 304 μ wide and 280 μ long, whereas ganglion 8 was 310 μ wide and 278 μ long.

In subgroup 2b the union of the two ganglia is so complete that their individual sizes cannot be ascertained. The composite character of ganglion 7 + 8 is borne out, however, by the number of nerves leaving the ganglion as well as by the mode in which the tracheae are arranged.

The distribution of tracheae in the ganglion 7+8 deserves to be mentioned separately. In the first group, in which there

Table XXXIII

Size of the last abdominal ganglion resulting from a union of ganglia 7 and 8 (in microns)

No.	Name of species	Instar	Width of the head	Width × length of ganglia		
				6-th	7-th	8-th
1.	*Fumea casta* Pall.	I	298	74×80	70×77	80×102
2.	,, ,, ,,	III	523	112×141	106×128	115×163
3.	,, ,, ,,	III	579		108×131	128×144
4.	,, ,, ,,	IV	679		96×154	112×179
5.	*Sterhopteryx hirsutella* Hbn.	III	780	113×124	119×113	141×146
6.	*Canephora unicolor* Hufn.	III	812		234×214	275×240
7.	,, ,,	IV	1043	203×203	158×180	180×192
8.	*Dendrolimus pini* L.	III	2117	329×307	318×250	318×307
9.	*Cuculia verbasci* L.	?	2224	318×318	307×239	329×269
10.	*Coscinia cribraria* L.	III	624	118×118	144×80	144×112

is no union of ganglia 7 and 8, there are three possible modes of distribution of the tracheae of the two ganglia.

1. Each of the ganglia receives a pair of tracheae in the form of ganglionic branches from a tracheal commissure of another abdominal segment. Ganglion 7 receives the branches from commissure 7 on the ventral side of segment 7, and ganglion 8 receives them from a similar commissure of segment 8 [Pl. LXX, 9].

Such conditions exist, I found, in *Talaeporia tubulosa* Retz. [Pl. LXX, 9], *Chimabacche fagella* F. and *Hyponomeuta malinellus* Z. and *Zygaena* F.

2. The pair of branches originating in tracheal commissure 7, forks and supplies ganglia 7 and 8. This is the case in *Evetria resinella* L., [Pl. LXXI, 13], *Laspeyresia pallifrontana* Z., *Gelechia malvella* Hbn., *Cacoecia piceana* L. and *Coleophora laricella* Hbn.

3. Two pairs of ganglionic branches originate in tracheal commissure 7. One pair supplies ganglion 7, and the other

one ganglion 8. This applies to *Bucculatrix frangulella* Goeze [Pl. LXX, 10].

In group 2, in which there is a union of ganglia 7 and 8, there are two possibilities:

1. The ganglia are perfectly united, but ganglion 7 is supplied with ganglionic branches from tracheal commissure 7, and ganglion 8, from commissure 8. Thus, the composite character of ganglion 7+8 is borne out not merely by the number of ganglionic nerves, but also by the arrangement of tracheae. This applies to *Psychidae*, e. g., *Fumea casta* Pall. [Pl. LXXI, 14] and *Sterhopteryx hirsutella* Hbn., *Eupithecia pulchellata* Steph., *Cuculia verbasci* L., *Phalera bucephala* L., *Dendrolimus pini* L. and *Coscinia cribraria* L. [Pl. LXXI, 15].

2. Ganglion 7 of the composite ganglion 7+8 is supplied with a pair of branches from tracheal commissure 6, and ganglion 8 receives them from commissure 7. This is the least primitive case and I noted it merely in *Ephestia kühniella* Z. [Pl. LXXI, 17].

The cases referred to above, in which there is a union of ganglia 7 and 8 resulting in a composite ganglion of the ventral nerve cord, ought to be taken to represent a kind of concentration taking place in the nervous system.

The union of the two ganglia is accompanied by a forward shift.

1. In the most primitive case there are no signs of shifting of the ganglia 7 and 8 which are in segments 7 and 8 respectively. This form represents, with some reservations, the larva of *Nepticula myrtillella* HS., in which I found the two ganglia distributed in the manner referred to before. Beside such, however, I met also with al arva of *Nepticula myrtillella* HS. whose both ganglia 7 and 8, were in segment 7.

2. On the second place I should put larvae in which there is no union of ganglia 7 and 8, which separately in segments 6 and 7 respectively. I found this to be the case in *Incurvaria muscalella* T. and *I. oehlmanniella* Tr., in *Cacoecia piceana* L. and *Zygaena* F. (first instar).

3. In many larvae, the two ganglia, without being united, lie in the seventh segment or between the sixth and seventh segments. This situation obtains in the larvae of *Talaeporia*

tubulosa Retz., *Nepticula septembrella* Stt., *Bucculatrix frangulella* Goeze [Pl. LXX, 10], *Chimabacche fagella* F.

4. The two ganglia are united and lie in segment 7. This applies to *Homoesoma nimbella* Z., *Evetria resinella* L. (Pl. LXXI, 13), *Coscinia cribraria* L. [Pl. LXXI, 15], *Arctia caja* L.

5. In some larvae the composite ganglion 7+8 lies between the abdominal segments 6 and 7. This abtains in *Fumea casta* Pall. [Pl. LXXI, 14] and *Fumea crassiorella* Brd. and *Sterhopteryx hirsutella* Hbn.

6. In the most extreme case, the united ganglia 7 and 8 are in segment 6. I found this situation merely in *Gelechia malvella* Hbn.

Not even traces of a concentration could be found in the following genera: *Nepticula* Z., *Leucoptera* Hbn., *Talaeporia* Hbn., *Hyponomeuta* Latr. and *Zygaena* F., which might be indicative of the primitiveness of these forms. I found the concentration in the ventral nerve cord to be most pronounced in the genera: *Ephestia* Gn., *Homoeosoma* Curt., *Eurrhypara* Hbn. (all three of the family *Pyralidae*) and in *Coscinia* Hbn., *Phalera* Hbn. and *Vanessa* F.

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STRESZCZENIE

W części II pracy nad topografią centralnego systemu nerwowego gąsienic motyli uwzględniono nie tylko gatunki minujące liście, lecz również żerujące w łodygach, pączkach liściowych i kwiatowych, w kwiatach, owocach i nasionach, a nadto żyjące na powierzchni roślin. Ogółem uwzględniono w obu pracach 85 gatunków, przedstawicieli 26 rodzajów.

W wyniku badań okazało się, że położenie nerwowych zwojów głowowych może być różne: pierwsza grupa gąsienic motyli ma zwoje głowowe (tj. zwój nadprzełykowy zwany także mózgiem i zwój podprzełykowy) przez całe życie w tułowiu (spis przebadanych gatunków na str. 50). Gąsienice tych motyli mają głowę zbudowaną prognatycznie, pozbawioną sutura coronalis lub z krótkim szwem ciemieniowym; wskaźnik epikranialny (Ep. i. w tabelach) nie daje się obliczyć z powodu braku sutura coronalis lub jest większy od 2 [Tab. XXIX Categ. I i Tab. XXX Categ. I; Pl. LXVIII, 1, Pl. LXX, 9, 12].

Druga grupa gąsienic ma zwoje głowowe w pierwszych okresach rozwojowych w tułowiu, a z końcem rozwoju (skutkiem szybszego wzrostu głowy niż mózgu) w otworze potylicowym lub głębiej w głowie (spis zaliczonych tu gatunków na str. 50). Ma ona przy tym głowę typu prognatycznego lub pośredniego między typem prognatycznym a ortognatycznym, z sutura coronalis dłuższą niż w grupie pierwszej; wskaźnik epikranialny jest większy od jedności, a na ogół mniejszy od 2 [Tab. XXIX Categ. II i Tab. XXX Categ. II, Pl. LXIX, 2, 4, 5, Pl. LXX, 6, Pl. LXXI, 16].

Trzecia grupa gąsienic ma nerwowe zwoje głowowe w głowie już od pierwszego okresu życia począwszy. Spośród ga-

tunków przebadanych zaliczyć tu trzeba wymienione na str. 9—10 od No. 35—57 z wyjątkiem 52. Gąsienice tych gatunków mają głowę zbudowaną ortognatycznie; wskaźnik epikranialny ma zwykle wartość ułamka [Tab. XXIX Categ. III, Tab. XXX Categ. III].

Zdaniem autora przesunięcie zwojów głowowych, jakie daje się zauważyć u wielu gąsienic motyli, związane jest z prognatyzmem ich głowy, a tylko częściowo ze sposobem ich życia w ciasnych przestrzeniach, np. w minach, koszyczkach, w zwiniętych w rurkę liściach, w mące itp. Wiązanie przesunięć nerwowych zwojów głowowych w tułów jedynie ze sposobem życia gąsienic w ciasnych przestrzeniach nie byłoby słuszne, wobec istnienia gąsienic żerujących swobodnie na powierzchni liści, a wykazujących przesunięcia zwojów głowowych do tułowia we wczesnych stadiach rozwojowych.

Prócz topografii centralnego systemu nerwowego głowy omówiono w pracy topografię brzusznego łańcucha nerwowego. Zwrócono uwagę na ujawniającą się w łańcuchu brzusznym koncentrację zwojów nerwowych. Polega ona na przesuwaniu się pierwszego zwoju odwłokowego ku przodowi, na zrastaniu się zwoju 7 z 8 i na przesuwaniu się obu zwojów ku przodowi. Poza tym omówiono różne typy utchawkowienia ostatnich zwojów abdominalnych.

РЕЗЮМЕ

В настоящей второй части работы над топографией нервной системы гусениц бабочек рассмотрены не только виды, минирующие листья, но также живущие в стеблях, в листовых и цветковых почках, в цветах, плодах и семенах и сверх того живущие на поверхности растений. В общем рассмотрено в обеих частяхработы 85 видов, принадлежащих к 26 родам.

В результате исследований оказалось, что положение нервных головных узлов может лыть различно: у первой группы гусениц бабочек головные узлы (надглоточный, называемый также мозгом, и подглоточный) находятся постоянно в груди (список этих видов на стр. 49). Гусеницы этих видов имеют голову прогнатическохо

строения без sutura coronalis или с коротким теменным швом. Эпикраниального индекса (Ep. i. в таблицах) невозможно вычислить, вследствие отсутствия sutura coronalis или он больше двух [Tab. XXIX Categ. I, Tab. XXX Categ. I; Plate LXVIII, fig. I, Plate LXX, fig. 9, 12].

У второй группы головные узлы в рервых периодах развития помещаются в груди, а в конце развития (вследствие более быстрого роста головы чем мозга) в затылочном отверстии или глубже в голове (список относящихся сюда видов на стр. 50). Кроме того голова здесь прогнатического типа или промежуточного между типом прогнатическим и ортогнатическим с более длинной sutura coronalis, чем у первой группы. Эпикраниальный иидекс больше единицы, но в общем меньше 2 [Tab. XXIX, Categ. II, Tab. XXX, Categ. II; Pl. LXIX, fig. 2, 4, 5, Pl. LXX, fig. 6, Pl. LXXI, fig. 16].

У третьей группы гусениц нервные головные узлы уже с первого периода жизни в голове. Среди исследованных видов принадлежат сюда виды, указанные на стр. 9—10 от № 35 до № 57, за исключением № 52. Голова гусениц этих видов построена ортогнатически; эпикраниальный индекс обыкновенно меньше единицы.

По мнению автора перемещения головных узлов, какие можно заметить у гусениц бабочек, связаны с прогнатизмом их головы, а только частично с образом их жизни в тесных пространствах, например, в минах, корзиночках, в свернутых в трубочку листьях, в муке и т. д. гусеницы, питающиеся свободнон на поверхности листьев, еекоторые обнаруживают подобные перемещение головных узлов в грудь в ранних стадиях развития. Кроме топографии центральной нервной системы головы, рассмотрена в настоящей работе и топография брюшной нервной цепочки. Обращено внимание на проявляющуся в брюшной цепочке концентрацию нервных узлов. Она состоит в передвижении вперед первого брюшного узла, в срастании 7 и 8 узлов и в передвижении вперед обоих узлов. Кроме того рассмотрены различные типы трахеизации последних брюшных узлов.

PLATES

PLATE LXVIII

Fig. 1. Larva of *Incurvaria oehlmanniella* Tr. Head and part of thorax. The mine was found on July 23, 1951, in a leaf of *Cornus sanguinea* L. at Czerny near Krzeszowice. The larva was removed from the case in its last stage of life on September 15, 1951, and photographed alive. 1 — prothorax, 2 — mesothorax, m — brain (ganglion supraoesophageum), po — suboesophageal ganglion (ganglion suboesophageum). Phot. J. Wilburg.

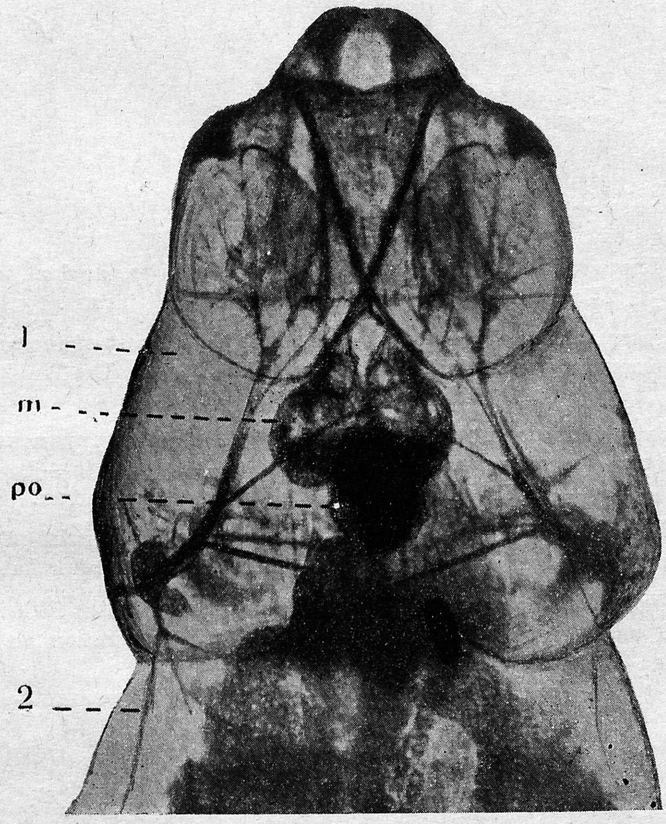

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PLATE LXIX

Fig. 2. Larva of *Ephestia kühniella* Z. Head with brain prepared on August, 2, 1955. The larva was in one of the final instars.

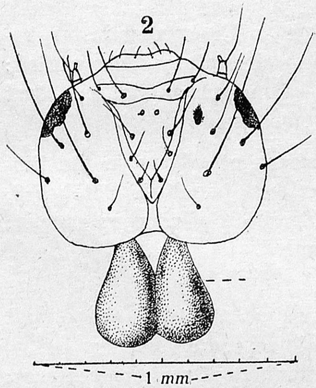
Fig. 3. Larva of *Laspeyresia grossana* Hw. Head and part of thorax. The specimen was found in a fruit of *Fagus silvatica* L. in the Las Wolski near Cracow on July 23, 1953.

Fr. — ganglion frontale, m — brain (ganglion supraoesophageum), ms — mesothorax, pr — prothorax, st — stigma, tr — tracheae, s — outline of the dorsal scutum on the prothorax.

Fig. 4. Larva of *Coscinia cribraria* L. Head together with brain (m). The larva was reproduced on July 29, 1953, an the first day after hatching.

Fig. 5. Larva of *Spilarctia lutea* Hufn. Head of larva in the fifth instar. Hatched on July 28, 1955. Reproduction after a preparation made on August 19, 1955.

2



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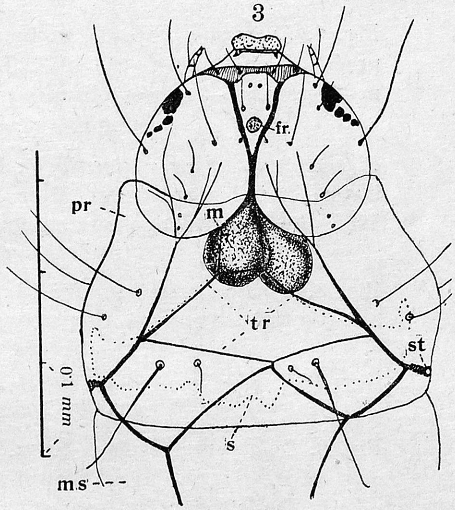

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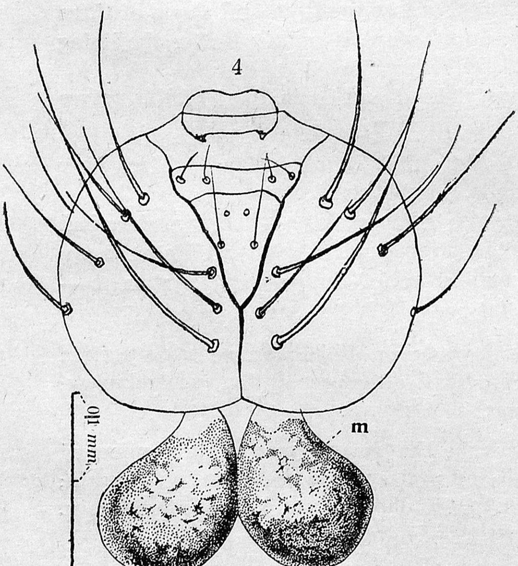

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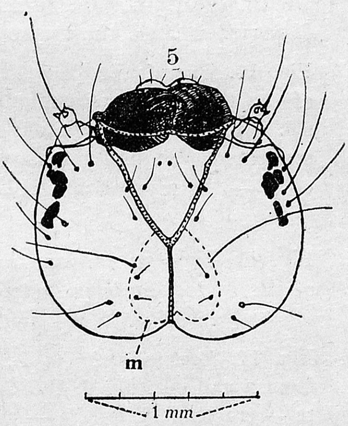

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PLATE LXX

Fig. 6. *Zygaena sp.* Head and thorax of a larva in the second instar, reproduced on August 30, 1953. Lateral view, chaetotaxy disregarded; m — brain, p — suboesophageal ganglion, t — thoracic ganglia, a — first abdominal ganglion, tr — tracheae.

Fig. 7. *Ocnerostoma piniariella* Z. Head and thorax of a larva in the first instar; lateral view; drawn after a living specimen found on October 3, 1954; the dashed line shows outlines, size and position of nervous ganglia; tracheal system disregarded.

Fig. 8. *Zygaena sp.*, first larval instar.
a — ventral nerve cord, prepared in toto on August 21, 1953; shape, and size relations preserved; diagramatic reproduction.
b — four distal abdominal ganglia with the beginnings of ganglionic nerves; ganglia 7 and 8 separate.

Fig. 9. *Talaeporia tubulosa* Retz. Ultimate larval instar, found in Las Wolski near Cracow.

On the left side: arrangement of tracheae, position and shape of three distal abdominal nervous ganglia, dorsal view; reproduced after the living specimen on September 6, 1953.

On the rigth side: dorsal view of head and brain; part of the nerves disregarded since they were invisible in vivo.

Fig. 10. *Bucculatrix frangulella* Goeze; fifth larval instar; ventral view of the two distal abdominal ganglia, reproduced in vivo.
s 6. and s 7. — abdominal segments; g 7, and g 8. — the two terminal separate abdominal ganglia with the chromatophores (ch) visible on them; co 7. — the seventh abdominal commissure of the tracheal system; c — fat-body.

Fig. 11. *Zygaena sp.* larva, 1-st day of life. Head and anterior portion of the central nervous system reproduced after preparation, ventral view; notations as in Fig. 6.

Fig. 12. *Evetria resinella* L. Larva in the second year of life, removed from a gall on July 6, 1953. Head and prothorax, dorsal view. m — brain; tr — tracheal system; s — outline of the dorsal scutum on the prothorax.

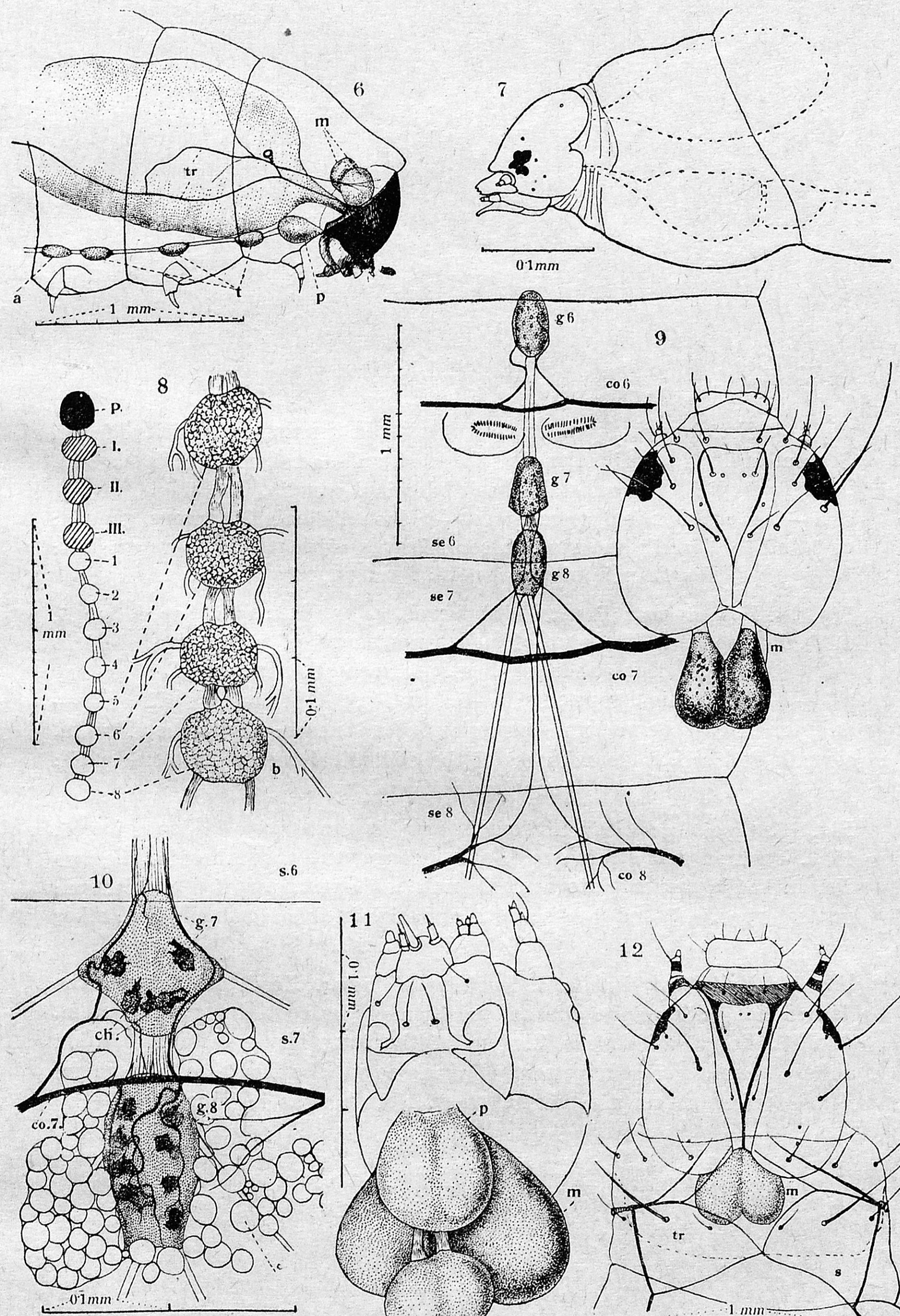

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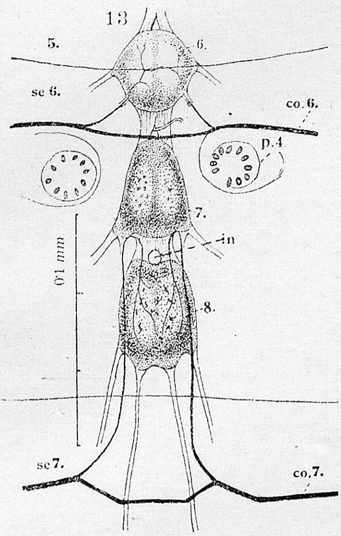
PLATE LXXI

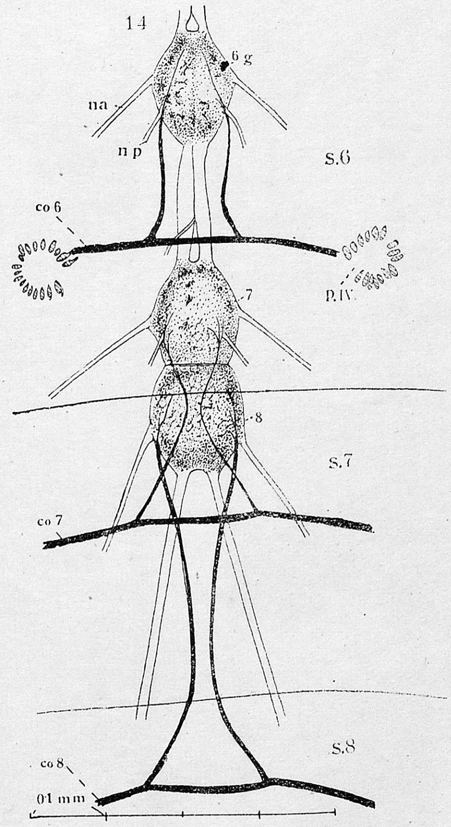
Fig. 13. *Evetria resinella* L.; larva collected in the first year of its life, on September 18, 1953. Position and shape of, and arrangement of trachea in, the distal three abdominal ganglia.
se 5 — se 7: abdominal segments; 6—8: last abdominal nervous ganglia; co 6 and co 7: sixth and seventh commissures of the tracheal system; p 4: fourth pair of prolegs; in: interconnective field.

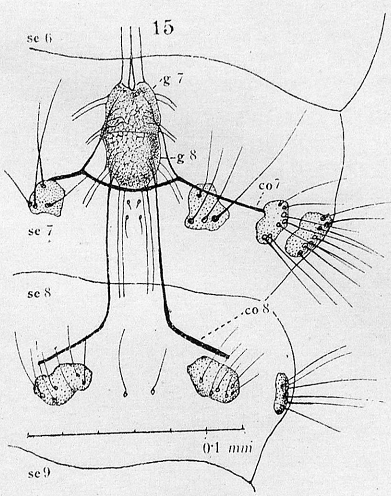
Fig. 14. *Fumea casta* PALL. Third larval instar, drawn on September 5, 1953. Position and structure of, and arrangement of tracheae in, the last three abdominal ganglia; ventral view.
s 6 — s 8: abdominal segments; 6—8: last three abdominal ganglia; na: — anterior lateral nerve; np.: posterior lateral nerve; co 6 — co 8: sixth, seventh and eighth commissures of the abdominal tracheal system; p IV: fourth pair of prolegs.

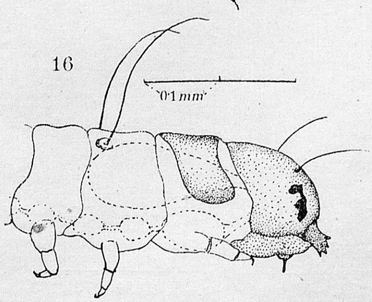
Fig. 15. *Coscinia cribaria* L. Fourth larval instar, drawn on September 5, 1953. Position and structure of, and arrangement of trachea in, the two distal ganglia merged into a single unit without traces of a coarctation; ventral view. g 7 and g 8: seventh and eighth abdominal ganglion; other details as in Fig. 13.

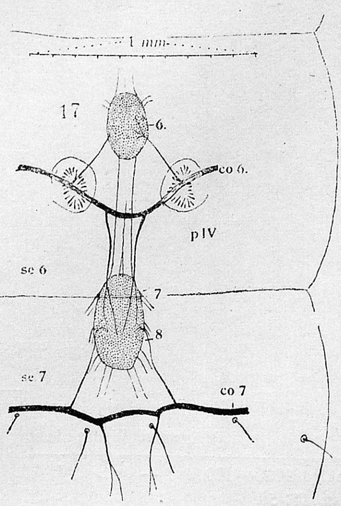
Fig. 16. *Ephestia kühniella* Z. First larval instar. Head and thorax. The dashed line outlines the size and position of the central nervous system.
Fig. 17. *Ephestia kühniella* Z. One of the later larval instars. Position and shape of, and arrangement of tracheae in, the last three abdominal nervous ganglia; ventral view. Notations as in Fig. 13.











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