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Dynamics of the avifauna during the Paleogene and the Early Neogene of France. Settling of the recent fauna

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Abstract. The comparison between the avifaunas of the Eocene and Oligocene of Phosphorites du Quercy and those of the Oligocene and Lower Miocene (Saint-Gérand-le-Puy) of central France shows that the proportion of extinct families decreases considerably during the Eocene-Miocene period. However, the avifaunas of the Upper Oligocene of central France, which include a large number of aquatic forms, come in their composition relatively close to the avifaunas of the Lower Miocene of the same region. Most fossil taxa of the Lower Miocene belong to Recent families, and the differences between the fossil and Recent faunas mainly concern genera and species.

Key words: Avifaunal dynamics, Paleogene, Neogene, Recent, France.

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I. INTRODUCTION

The avifauna from the Paleocene, Lower Eocene, and Middle Eocene of France was dominated by large, flightless birds, such as the Gastornithidae (*Gastornis*, *Diatryma*), or Ratites (*Remiornis*) (ANDORS 1992; MARTIN 1992). There were also large owls of the family Sophiornithidae (MOURER-CHAUVIRÉ 1994) and Messel-rails of the family Messelornithidae (MOURER-CHAUVIRÉ, in press). Smaller forms were present, too, but they have not yet been studied in detail.

On the contrary, there was a great diversity of small birds in the localities of Phosphorites du Quercy, in South-West France, referred to a period from the beginning of the Upper Eocene to almost the end of the Upper Oligocene (Fig. 1). The localities of Quercy are karstic fillings, where the bird remains mainly come from the food of raptorial birds, which implies a bias towards a larger representation of smaller forms.

The first bird remains were gathered during the phosphate mining activities at the end of the 19th century. Unfortunately, this material has neither accurate geographic localization nor accurate dating. It may only be said that its age is comprised between the Upper Eocene and the Upper Oligocene. These early collections were studied by LYDEKKER (1891), MILNE-EDWARDS (1892),

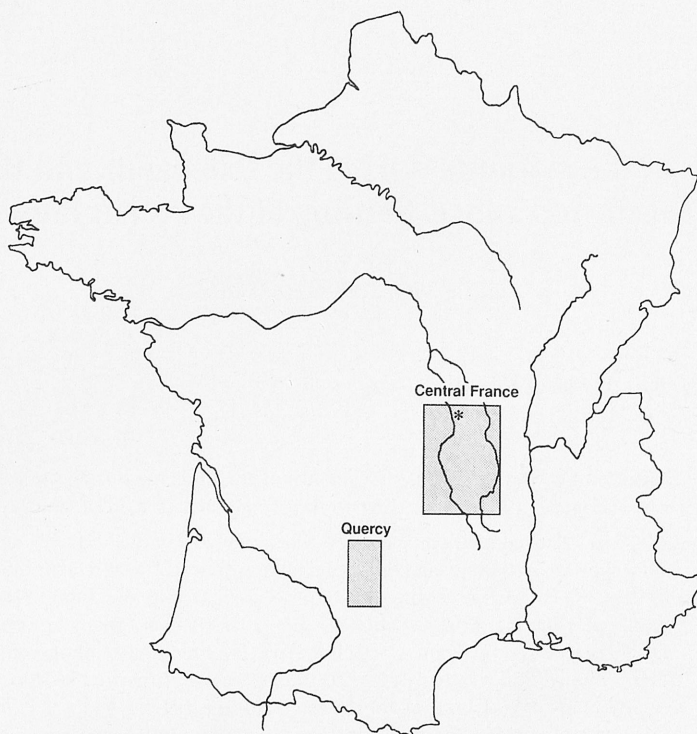


Fig. 1. Diagrammatic map of France showing the position of Phosphorites du Quercy (Upper Eocene and Oligocene) and of Central France localities (Oligocene and Lower Miocene). The asterisk indicates the locality of Saint-Gérard-le-Puy.

GAILLARD (1908, 1939), CRACRAFT & RICH (1972), CRACRAFT (1973), COLLINS (1976 a), MLIKOVSKY (1989 a, b).

Since the 1960s new excavations have been carried out in the Quercy by research workers of the Universities of Montpellier and Paris 6. During these excavations bird remains were found in a certain number of well-defined localities. The associated faunas of small mammals made it possible accurately to situate the localities in the Mammalian Reference Levels of the Paleogene (MP zones) (REMY et al. 1987; SCHMIDT-KITTLER et al. 1987). The following works include both descriptions of new material and revisions of the old collections: MOURER-CHAUVIRÉ (1978, 1980, 1981, 1982, 1983, 1985, 1987, 1988 a, b, and c, 1991, 1992 a, b, and c, 1993, 1995), KARKHU (1988), MOURER-CHAUVIRÉ & CHENEVAL (1983). The study and the revision of this material is not yet completely finished. The complete list of the species so far identified from Quercy is given in Annex 1.

II. QUERCY EOCENE AVIFAUNAS

In the material coming only from the exactly dated Eocene localities of Quercy (Table I), 20 bird families have so far been identified, and among them 12 are extinct and 8 are Recent. From among these 8 Recent families, 5 do not occur any longer in Europe (Cathartidae, Hemiprocridae, Podargidae, Coliidae, and Todidae), and 3 still do (Recurvirostridae, Tytonidae, Caprimulgidae)

Table I

List of the taxa identified from the strictly dated Eocene localities of Phosphorites du Quercy. The extinct families are indicated by E. Localities: MP (Mammalian Paleogene) 16 – Le Bretou, Lavergne; MP 17 – La Bouffie, Les Pradigues, Salesmes, Perrière; MP 18 – Sainte Néboule; MP 19 – Escamps, Lostanges, Rosières 1 and 2.

Family	Genus and species	MP 16	MP 17	MP 18	MP 19
Cathartidae	<i>Diatropornis ellioti</i>	+	–	–	–
Horusornithidae (E.)	<i>Horusornis vianeyliaude</i>	–	+	–	–
Gallinuloididae (E.)	<i>Taoperdix</i> sp.	+	–	–	–
Paraortygidae (E.)	<i>Paraortyx loreti</i>	–	+	–	+
	<i>Paraortyx brancoi</i>	–	–	+	+
Quercymegapodiidae (E.)	<i>Quercymegapodius depereti</i>	–	–	+	+
	<i>Quercymegapodius brodkorbi</i>	+	+	–	+
Idiornithidae (E.)	<i>Elaphrocnemus phasianus</i>	–	–	–	+
	<i>Idiornis gallicus</i>	+	+	–	+
	<i>Idiornis minor</i>	–	+	–	–
	<i>Idiornis gaillardi</i>	+	+	–	+
Phororhacidae (E.)	undetermined	+	–	–	–
Recurvirostridae	<i>Recurvirostra sanctaeneboulae</i>	–	–	+	–
Aegialornithidae (E.)	<i>Aegialornis gallicus</i>	+	+	–	–
	<i>Aegialornis leenhardti</i>	+	+	–	–
	<i>Aegialornis wetmorei</i>	+	+	–	–
	<i>Aegialornis broweri</i>	–	–	+	–
Hemiprocnidae	<i>Cypselavus gallicus</i>	+	+	–	–
Jungornithidae (E.)	<i>Palescyvus escampensis</i>	–	–	–	+
Tytonidae	<i>Necrobyas rossignoli</i>	–	+	–	cf. +
	<i>Nocturnavis incerta</i>	–	–	–	+
Palaeoglaucidae (E.)	<i>Palaeoglaux perrierensis</i>	–	+	–	–
Quercypsittidae (E.)	<i>Quercypsitta sudrei</i>	–	+	–	–
	<i>Quercypsitta ivani</i>	–	+	–	–
Archaeotrogonidae (E.)	<i>Archaeotrogon venustus</i>	–	+	–	+
Caprimulgidae	<i>Ventivorus ragei</i>	+	–	–	–
Podargidae	<i>Quercypodargus olsoni</i>	+	–	–	–
Coliidae	<i>Primocolius sigei</i>	+	+	–	+
	<i>Primocolius minor</i>	–	+	–	+
Sylphornithidae (E.)	<i>Sylphornis bretouensis</i>	+	–	–	–
Todidae	<i>Palaeotodus escampsiensis</i>	–	–	–	+

(Table IV; Fig. 2 and 3). A large number of the birds found in the Eocene localities are small perching birds: arboreal, for example the Coliidae and the Todidae among the Recent families, or probably arboreal, for example the Horusornithidae, the Paraortygidae, the Aegialornithidae, the Quercypsittidae and the Sylphornithidae among the extinct families.

Other main components of the Quercy avifaunas are the Idiornithidae. They are diversified in the Eocene localities and probably correspond to the environment of grasslands with scattered

bushes, like the Recent Cariamidae which are their nearest relatives. The aquatic or marshy forms are very rare and have not as yet been studied. They include mainly Rallidae and one Recurvirostrid.

III. QUERCY OLIGOCENE AVIFAUNAS

In the material coming only from the exactly dated Oligocene localities of Quercy (Table II), from among 12 families, 6 are extinct and 6 Recent. In the 6 Recent families, 3 do not occur any longer in Europe (Sagittariidae, Hemiprocridae, Todidae), and 3 are still present there (Phasianidae, Pteroclididae, Tytonidae) (Table IV; Fig. 2 and 3). The Idiornithidae are still important and more diversified than they were during the Eocene, small arboreal forms being abundant, and there appear some savannah forms from , such as the Sagittariidae, or those of semi-desert regions, such as the Pteroclididae.

Table II

List of the taxa identified from the strictly dated Oligocene localities of Phosphorites du Quercy. The extinct families are indicated by E. Localities: MP (Mammalian Paleogene) 21 – Aubrelong 1, Ravet-Lupovici; MP 22 – La Plante 2, Mas de Got; MP 23 – Roqueprune, Mounayne, Pech Crabit, Itardiès; MP 25 – Belgaric, Garouillas; MP 26 – Mas de Pauffié (unpublished); MP 28 – Pech Desse, Pech du Fraysse

Family	Genus and species	MP 21	MP 22	MP 23	MP 25	MP 26	MP 28
Sagittariidae	<i>Pelargopappus schlosseri</i>	—	—	+	—	—	+
Paraortygidae (E.)	<i>Paraortyx lorteti</i>	+	+	+	—	—	—
	<i>Pirortyx major</i>	—	—	—	—	—	+
Phasianidae	<i>Palaeortyx brevipes</i>	—	—	—	+	—	+
	<i>Palaeortyx gallica</i>	—	—	—	—	—	+
	<i>Palaeortyx intermedia</i>	—	—	—	—	—	+
Messelornithidae (E.)	<i>Itardiornis hessae</i>	—	—	+	—	—	—
Idiornithidae (E.)	<i>Elaphrocnemus phasianus</i>	+	—	—	—	—	—
	<i>Elaphrocnemus crex</i>	—	+	+	—	—	+
	<i>Idiornis cursor</i>	—	+	+	—	—	+
	<i>Idiornis gracilis</i>	—	—	+	+	—	—
	<i>Idiornis itardiensis</i>	—	—	+	—	—	+
Phororhacidae (E.)	<i>Ameghinornis minor</i>	—	—	+	—	—	—
Pteroclididae	<i>Leptoganga sepultus</i>	—	—	—	—	—	+
Hemiprocridae	<i>Cypselavus gallicus</i>	—	—	+	—	—	—
Tytonidae	<i>Necrobyas harpax</i>	+	+	+	—	—	—
	<i>Necrobyas edwardsi</i>	—	—	—	—	—	+
	<i>Necrobyas minimus</i>	—	—	+	—	—	—
cf. Sophiornithidae (E.)	cf. <i>Sophiornis quercynus</i>	—	—	—	+	—	—
Archaeotrogonidae (E.)	<i>Archaeotrogon venustus</i>	—	+	+	—	—	+
	<i>Archaeotrogon zitteli</i>	—	+	—	—	—	+
	<i>Archaeotrogon cayluxensis</i>	—	—	—	+	—	+
Todidae	<i>Palaeotodus itardiensis</i>	—	—	+	—	—	—
Passeriformes: Suboscines							
Undetermined family	Undet. genus and species	—	—	—	—	+	—

IV. OLIGOCENE AVIFAUNAS FROM CENTRAL FRANCE

The Lower Oligocene and Upper Oligocene avifaunas from the central part of France are very different from the Oligocene avifaunas of Quercy (Fig. 1). They are mainly known from the localities of Chaptuzat, La Sauvetat, Antoingt (MP 25), Cournon (MP 28), Pont-du-Château (MP 29), Gannat and Gergovie (MP 30) (GERVAIS 1848-52; MILNE-EDWARDS 1867-71; LYDEKKER 1891; LAMBRECHT 1933; BRODKORB 1963, 1964, 1967; HARRISON 1975 a and b; CHENEVAL, 1984 a; MOURER-CHAUVIRÉ et al., 1989) (Table III). These avifaunas have been found mostly in lacustrine deposits and include mainly aquatic forms belonging to the families Palaelodidae, Phoenicopteridae, and Laridae, as well as Sulidae and Gruidae at the locality of Gannat. The Palaelodidae, Phoenicopteridae, and Sulidae are still totally unknown in the Quercy fossiliferous localities. All the species found in these Oligocene localities of central France (*Palaelodus ambiguus*, *P. crassipes*, *P. gracilipes*, *Phoenicopterus croizeti*, *Empheresula arvernensis*, *Probalearica problematica*, *Larus elegans*) are still present in the rich Lower Miocene (Aquitanian, MN 2a) avifaunas of the Saint-Gérand-le-Puy area in the same region. A change in the avifauna, occurring between the Upper Oligocene and the Lower Miocene, is demonstrated by the appearance of new orders and families, with the rest of the avifauna staying unchanged when the environment remains the same, i. e. in our case, predominantly lacustrine. Great differences visible between the Upper Oligocene avifauna from Quercy, on the one hand, and that from the centre of France, on the other hand, are related to different ecological conditions. The Quercy avifaunas mainly include forms from forests or savannahs with scattered bushes, while those from the centre of France mainly include aquatic forms.

Table III

List of the taxa identified from the strictly dated Oligocene localities of central France. The extinct families are indicated by E. Localities: MP (Mammalian Paleogene) 21 – Ronzon (Haute-Loire); MP 25 – Chaptuzat (Puy-de-Dôme), La Sauvetat (Puy-de-Dôme), Antoingt (Puy-de-Dôme); MP 28 – Cournon (Puy-de-Dôme); MP 29 – Pont du Château (Puy-de-Dôme); MP 30 – Gergovie (Puy-de-Dôme), Coderet (Allier), Gannat (Allier), Peulblanc (Allier)

Family	Genus and species	MP21	MP25	MP28	MP29	MP30
Sulidae	<i>Sula ronconi</i>	+	—	—	—	—
	<i>Empheresula arvernensis</i>	—	—	—	—	+
Palaelodidae (E.)	<i>Palaelodus ambiguus</i>	—	+	+	+	+
	<i>Palaelodus gracilipes</i>	—	—	—	—	+
	<i>Palaelodus crassipes</i>	—	—	—	—	+
Phoenicopteridae	<i>Elornis litoralis</i>	+	—	—	—	—
	<i>Elornis grandis</i>	+	—	—	—	—
	<i>Phoenicopterus croizeti</i>	—	+	+	—	+
Accipitridae	<i>Palaeohierax gervaisii</i>	—	+	—	—	—
Gruidae	<i>Probalearica problematica</i>	—	—	—	—	+
Scolopacidae	<i>Calidris gracilis</i>	—	—	—	—	+
Laridae	<i>Larus elegans</i>	—	+	—	—	+
Passeriformes: Oscines						
Undetermined family	Undet. genus and species	—	—	—	—	+
Family inaeptae sedis	<i>Teracus littoralis</i>	+	—	—	—	—
	<i>Delichopterus viator</i>	+	—	—	—	—

V. LOWER MIOCENE AVIFAUNA OF SAINT-GÉRAND-LE-PUY IN CENTRAL FRANCE

In the Lower Miocene avifaunas the proportion of extinct families decreases still more. In the large fossil bird assemblage of the Saint-Gérard-le-Puy area, at the present state of revision of the data, among 35 families identified there are only two extinct ones, namely the Palaelodidae and the Quercymegapodiidae. Out of the remaining 33 families, only 5 do not occur any longer in Europe (Sagittariidae, Psittacidae, Coliidae, Trogonidae, and Phoeniculidae) (Table IV; Fig. 2 and 3). Annex 2 presents a complete list of the species as yet identified from the localities of the Saint-Gérard-le-Puy area, compiled on the basis of works by GERVAIS (1848-52), MILNE-EDWARDS (1863, 1867-71), LYDEKKER (1891), LAMBRECHT (1933), GAILLARD (1939), BRODKORB (1963, 1964, 1967, 1971, 1978), BALLMANN (1969), CRACRAFT (1973), COLLINS (1976 b), HARRISON (1979), CHENEVAL (1982, 1983, 1984 a and b), MOURER-CHAUVIRÉ & CHENEVAL (1983), OLSON (1985), MOURER-CHAUVIRÉ (1987, 1992 b, 1993), LIVEZEY & MARTIN (1988).

The Aquitanian avifauna from Saint-Gérard-le-Puy differs from the older ones in the presence of orders and families which belong to the main components of the modern avifaunas and appear for the first time in the Northern Hemisphere, or become really important only at that time, namely, the Anatidae, Psittacidae, Columbidae and Passeriformes. As has already been emphasized by OLSON (1988), these taxa probably originated in the Southern Hemisphere and their expansion into the Northern Hemisphere did not occur before the Miocene. This hypothesis has been reinforced by the recent discovery of passerines in the Early Eocene of Australia (BOLES 1995).

If these orders or families originated in the Southern Hemisphere, they were probably not present in Africa in the Lower Tertiary, because the palaeogeographical reconstructions show that for flying forms communication was then possible between Europe and Africa. From the beginning of the Tertiary these two continents were only separated by relatively narrow straits in the West and, from the Upper Eocene onwards, the communication between them must have been rather similar to that which exists at the present time (DERCOURT et al. 1993; SMITH et al. 1994).

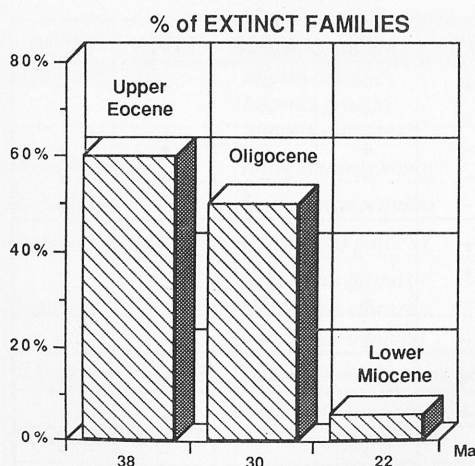


Fig. 2. Percentages of extinct families in the Upper Eocene and Oligocene of Quercy and in the Lower Miocene of Saint-Gérard-le-Puy.

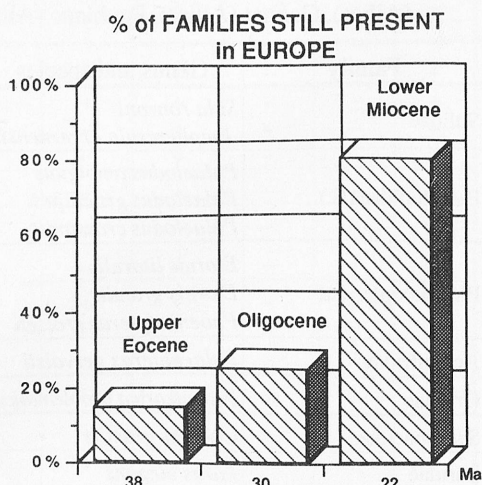


Fig. 3. Percentages of Recent families still present in Europe in the Upper Eocene and Oligocene of Quercy and in the Lower Miocene of Saint-Gérard-le-Puy.

Table IV

Number of extinct and Recent families in the Upper Eocene and Oligocene of Phosphorites du Quercy and in the Lower Miocene of Saint-Gérard-le-Puy

Localities	Number of families identified	Number of extinct families	Number of recent families	Families no longer present in Europe	Families still present in Europe
Phosphorites du Quercy Upper Eocene localities (Age: 40 to 36 Ma)	20	12	8	5	3
Phosphorites du Quercy Oligocene localities (Age: 36 to 24 Ma)	12	6	6	3	3
Saint-Gérard-le-Puy Lower Miocene (Age: 22 Ma)	35	2	33	5	28

This is also indicated by the fact that the bird families endemic in Africa are very few. Among the 9 families which are endemic in Africa at the present time, 5 have been found as fossils in Eurasia (Struthionidae, Sagittariidae, Musophagidae, Coliidae, Phoeniculidae), and thus their distribution has only recently been restricted to Africa, 2 have been found as fossils only in Africa (Scopidae, Balaenicipitidae), and the last 2 (Promeropidae, Prionopidae) are not as yet known as fossils.

So it is likely that the orders or families that have originated in the Southern Hemisphere were differentiated in one or several areas of that part of the Gondwanian continent formed by Antarctica, Australia and India. That part separated from the other one, formed by Africa and South America, during the Upper Jurassic and Lower Cretaceous. If the ancestral representatives of those groups were present, say in India, they may have reached the Eurasia continent at the time when India became united to it, i. e. at least during the Middle Eocene (DERCOURT et al. 1993), and from there they reached Western Europe. If they were present in Australia, they may have reached the Eurasian continent, possibly using islands as stepping stones, at the time when Australia became sufficiently close to Eurasia, i. e. from the Lower Miocene onwards (DERCOURT et al. 1993; SMITH et al. 1994). These two hypotheses may explain why these taxonomical units are found in Europe mainly from the Lower Miocene onwards.

It can be said in conclusion that starting from the Miocene the European avifaunas included a great majority of Recent families, still living in Europe or in more tropical environments. The latter ones progressively disappeared from Europe between the Miocene and the Pleistocene. Unlike the Paleogene avifaunas, which differ from the Recent ones mainly at family level, the Neogene avifaunas differ mainly at generic and specific levels.

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Annex 1
List of Quercy fossil birds as yet identified

O. Pelecaniformes

F. Phalacrocoracidae

Still undescribed genus and species

O. Ciconiiformes

F. Ardeidae

Genus *Proardea* LAMBRECHT, 1933

Proardea amissa (MILNE-EDWARDS, 1892)

F. Cathartidae

Genus *Plesiocathartes* GAILLARD, 1908

Plesiocathartes europaeus GAILLARD, 1908

Genus *Diatropornis* OBERHOLSER, 1899

Diatropornis ellioti (MILNE-EDWARDS, 1892)

O. Accipitriformes

F. Accipitridae

Genus *Aquilavus* LAMBRECHT, 1933

Aquilavus hypogaeus (MILNE-EDWARDS, 1892)

Aquilavus corroyi (GAILLARD, 1939)

F. Sagittariidae

Genus *Pelargopappus* STEJNEGER, 1885

[syn. *Amphiserpentarius* GAILLARD, 1908]

Pelargopappus schlosseri (GAILLARD, 1908)

[syn. *Pelargopsis stehlini* GAILLARD, 1908, and

Pelargopsis trouessarti GAILLARD, 1908]

F. Horusornithidae MOURER-CHAUVIRÉ, 1991

Genus *Horusornis* MOURER-CHAUVIRÉ, 1991

Horusornis vianeyliaudae MOURER-CHAUVIRÉ, 1991

F. Falconidae

Still undescribed genus and species

O. Galliformes

F. Gallinuloididae LUCAS, 1900

Genus *Taoperdix* MILNE-EDWARDS, 1869

Taoperdix sp.

F. Paraortygidae MOURER-CHAUVIRÉ, 1992

Genus *Paraortyx* GAILLARD, 1908

Paraortyx lorteti GAILLARD, 1908

[syn. *Palaeortyx cayluxensis* MILNE-EDWARDS, 1892]

Paraortyx brancoi GAILLARD, 1908

Genus *Pirortyx* BRODKORB, 1964

Pirortyx major (GAILLARD, 1939)

F. Quercymegapodiidae MOURER-CHAUVIRÉ, 1992

Genus *Quercymegapodius* MOURER-CHAUVIRÉ, 1992*Quercymegapodius depereti* (GAILLARD, 1908)*Quercymegapodius brodkorbi* MOURER-CHAUVIRÉ, 1992

F. Phasianidae

Subf. Phasianinae

Genus *Palaeortyx* MILNE-EDWARDS, 1869*Palaeortyx brevipes* MILNE-EDWARDS, 1869[syn. *Palaeortyx ocyptera* MILNE-EDWARDS, 1892]*Palaeortyx gallica* MILNE-EDWARDS, 1869*Palaeortyx intermedia* BALLMANN, 1966

O. Gruiformes

F. Idiornithidae BRODKORB, 1965

Genus *Elaphrocnemus* MILNE-EDWARDS, 1892[syn. pars *Filholornis* MILNE-EDWARDS, 1892]*Elaphrocnemus phasianus* MILNE-EDWARDS, 1892[syn. *Filholornis paradoxa* MILNE-EDWARDS, 1892,*Filholornis debilis* MILNE-EDWARDS, 1892, and*Telecrex peregrinus* MILKOVSKY, 1989]*Elaphrocnemus crex* MILNE-EDWARDS, 1892*Elaphrocnemus brodkorbi* MOURER-CHAUVIRÉ, 1983Genus *Idiornis* OBERHOLSER, 1899*Idiornis gallicus* MILNE-EDWARDS, 1892)[syn. *Filholornis gravis* MILNE-EDWARDS, 1892]*Idiornis cursor* MILNE-EDWARDS, 1892)[syn. *Orthocnemus major* MILNE-EDWARDS, 1892]*Idiornis minor* (MILNE-EDWARDS, 1892)*Idiornis gaillardi* CRACRAFT, 1973*Idiornis gracilis* (MILNE-EDWARDS, 1892)*Idiornis itardiensis* MOURER-CHAUVIRÉ, 1983Genus *Propelargus* LYDEKKER, 1891*Propelargus cayluxensis* LYDEKKER, 1891Genus *Occitaniavis* MOURER-CHAUVIRÉ, 1983[syn. pars *Geranopsis* LYDEKKER, 1891]*Occitaniavis elatus* (MILNE-EDWARDS, 1892)Genus *Oblitavis* MOURER-CHAUVIRÉ, 1983*Oblitavis insolitus* MOURER-CHAUVIRÉ, 1983

F. Phororhacidae AMEGHINO, 1889

Subf. Ameghinornithinae MOURER-CHAUVIRÉ, 1981

Genus *Ameghinornis* MOURER-CHAUVIRÉ, 1981[syn. pars *Strigogyps* GAILLARD, 1908]*Ameghinornis minor* (GAILLARD, 1939)

F. Messelornithidae HESSE, 1988

Genus *Itardiornis* MOURER-CHAUVIRÉ, 1995*Itardiornis hessae* MOURER-CHAUVIRÉ, 1995

F. Rallidae

- Genus *Quercyrallus* LAMBRECHT, 1933
Quercyrallus arenarius (MILNE-EDWARDS, 1892)
Quercyrallus dasypus (MILNE-EDWARDS, 1892)
Quercyrallus quercy CRACRAFT, 1973

F. Gruidae

Still undescribed genus and species

F. Otididae

Still undescribed genus and species

O. Charadriiformes

F. Recurvirostridae

- Genus *Recurvirostra* LINNAEUS, 1758
Recurvirostra sanctaeneboulae MOURER-CHAUVIRÉ, 1978

F. Scolopacidae

- Genus *Totanus* BECHSTEIN, 1803
Totanus edwardsi GAILLARD, 1908

F. Laridae

Still undescribed genus and species

O. Columbiformes

F. Pteroclididae

- Genus *Archaeoganga* MOURER-CHAUVIRÉ, 1992
Archaeoganga pinguis MOURER-CHAUVIRÉ, 1992
Archaeoganga larvatus (MILNE-EDWARDS, 1892)
Archaeoganga validus (MILNE-EDWARDS, 1892)
Genus *Leptoganga* MOURER-CHAUVIRÉ, 1993
Leptoganga sepultus (MILNE-EDWARDS, 1869)

O. Psittaciformes

F. Quercypsittidae MOURER-CHAUVIRÉ, 1992

- Genus *Quercypsitta* MOURER-CHAUVIRÉ, 1992
Quercypsitta sudrei MOURER-CHAUVIRÉ, 1992
Quercypsitta ivani MOURER-CHAUVIRÉ, 1992

O. Cuculiformes

F. Cuculidae

- Genus *Dynamopterus* MILNE-EDWARDS, 1892
Dynamopterus velox MILNE-EDWARDS, 1892
Dynamopterus boulei GAILLARD, 1939

O. Strigiformes

F. Tytonidae

Subf. *Necrobyinae* MOURER-CHAUVIRÉ, 1987

- Genus *Necrobyas* MILNE-EDWARDS, 1892
Necrobyas harpax MILNE-EDWARDS, 1892
Necrobyas rossignoli MILNE-EDWARDS, 1892
Necrobyas edwardsi GAILLARD, 1939
Necrobyas medius MOURER-CHAUVIRÉ, 1987
Necrobyas minimus MOURER-CHAUVIRÉ, 1987
- Genus *Nocturnavis* MOURER-CHAUVIRÉ, 1987
Nocturnavis incerta (MILNE-EDWARDS, 1892)
- Genus *Palaeobyas* MOURER-CHAUVIRÉ, 1987
Palaeobyas cracrafti MOURER-CHAUVIRÉ, 1987
- Genus *Palaeotyto* MOURER-CHAUVIRÉ, 1987
Palaeotyto cadurcensis MOURER-CHAUVIRÉ, 1987
- Subf. Selenornithinae MOURER-CHAUVIRÉ, 1987
 Genus *Selenornis* MOURER-CHAUVIRÉ, 1987
Selenornis henrici (MILNE-EDWARDS, 1892)
- F. Palaeoglaucidae MOURER-CHAUVIRÉ, 1987 (PETERS, 1992)
 Genus *Palaeoglaux* MOURER-CHAUVIRÉ, 1987
Palaeoglaux perrierensis MOURER-CHAUVIRÉ, 1987
- F. Sophiornithidae MOURER-CHAUVIRÉ, 1987
 Genus *Sophiornis* MOURER-CHAUVIRÉ, 1987
Sophiornis quercynus MOURER-CHAUVIRÉ, 1987
- Genus incertae sedis *Strigogyps* GAILLARD, 1908
Strigogyps dubius GAILLARD, 1908
- O. Caprimulgiformes
- F. Archaeotrogonidae MOURER-CHAUVIRÉ, 1980
 Genus *Archaeotrogon* MILNE-EDWARDS, 1892
Archaeotrogon venustus MILNE-EDWARDS, 1892
Archaeotrogon zitteli GAILLARD, 1908
Archaeotrogon cayluxensis GAILLARD, 1908
Archaeotrogon hoffstetteri MOURER-CHAUVIRÉ, 1980
- F. Caprimulgidae
 Genus *Ventivorus* MOURER-CHAUVIRÉ, 1988
Ventivorus ragei MOURER-CHAUVIRÉ, 1988
- F. Podargidae
 Genus *Quercypodargus* MOURER-CHAUVIRÉ, 1988
Quercypodargus olsoni MOURER-CHAUVIRÉ, 1988
- F. Nyctibiidae
 Genus *Euronyctibius* MOURER-CHAUVIRÉ, 1988
Euronyctibius kurochkini MOURER-CHAUVIRÉ, 1988
- ? F. Aegothelidae
 Still undescribed genus and species
- ? F. Steatornithidae
 Still undescribed genus and species

O. Apodiformes

F. Aegialornithidae LYDEKKER, 1891

Genus *Aegialornis* LYDEKKER, 1891[syn. *Tachyornis* MILNE-EDWARDS, 1892]*Aegialornis gallicus* LYDEKKER, 1891[syn. *Tachyornis hirundo* MILNE-EDWARDS, 1892]*Aegialornis lehnardti* GAILLARD, 1908*Aegialornis wetmorei* COLLINS, 1976*Aegialornis broweri* COLLINS, 1976

F. Hemiprocnidae

Genus *Cypselavus* GAILLARD, 1908*Cypselavus gallicus* GAILLARD, 1908

F. Apodidae

Genus *Cypseloides* STREUBEL, 1848*Cypseloides mourerchauvira* MLIKOVSKÝ, 1989

F. Jungornithidae KARKHU, 1988

Genus *Palescyvus* KARKHU, 1988*Palescyvus escampensis* KARKHU, 1988

O. Coliiformes

F. Coliidae

Genus *Primocolius* MOURER-CHAUVIRÉ, 1988*Primocolius sigei* MOURER-CHAUVIRÉ, 1988*Primocolius minor* MOURER-CHAUVIRÉ, 1988

O. Coraciiformes

F. Sylphornithidae MOURER-CHAUVIRÉ, 1988

Genus *Sylphornis* MOURER-CHAUVIRÉ, 1988*Sylphornis bretouensis* MOURER-CHAUVIRÉ, 1988

F. Todidae

Genus *Palaeotodus* OLSON, 1976*Palaeotodus escampensis* MOURER-CHAUVIRÉ, 1985*Palaeotodus itardiensis* MOURER-CHAUVIRÉ, 1985

F. Coraciidae

Genus *Geranopterus* MILNE-EDWARDS, 1892*Geranopterus alatus* MILNE-EDWARDS, 1892

F. Alcedinidae

Still undescribed genus and species

F. Meropidae

Still undescribed genus and species

F. Upupidae

Still undescribed genus and species

O. Passeriformes

Suborder Suboscines, undetermined family

Annex 2

List of fossil birds of Saint-Gérand-le-Puy area as yet identified

O. Gaviiformes

F. Gaviidae

Genus *Colymboides* MILNE-EDWARDS, 1867-71

Colymboides minutus MILNE-EDWARDS, 1867-71

O. Procellariiformes

F. Procellariidae

Genus *Plotornis* MILNE-EDWARDS, 1874

Plotornis arvernensis (MILNE-EDWARDS, 1867-71)

O. Pelecaniformes

F. Phalacrocoracidae

Genus *Phalacrocorax* BRISSON, 1760

Phalacrocorax littoralis (MILNE-EDWARDS, 1867-71)

Genus *Nectornis* CHENEVAL, 1984

Nectornis miocaenus (MILNE-EDWARDS, 1867-71)

F. Sulidae

Cf. genus *Empheresula* HARRISON, 1975

cf. *Empheresula arvernensis* (MILNE-EDWARDS, 1867-71)

F. Pelecanidae

Genus *Miopelecanus* CHENEVAL, 1984

Miopelecanus gracilis (MILNE-EDWARDS, 1863)

O. Ciconiiformes

F. Ardeidae

Genus *Proardeola* HARRISON, 1979

Proardeola walkeri HARRISON, 1979

F. Ciconiidae

Genus *Grallavis* CHENEVAL, 1984

Grallavis edwardsi (LYDEKKER, 1891)

F. Threskiornithidae

Genus *Plegadis* KAUP, 1829

Plegadis paganus (MILNE-EDWARDS, 1867-71)

O. Phoenicopteriformes

F. Palaelodidae (STEJNEGER, 1885)

Genus *Palaelodus* MILNE-EDWARDS, 1863

Palaelodus ambiguus MILNE-EDWARDS, 1863

Palaelodus gracilipes MILNE-EDWARDS, 1863

Palaelodus crassipes MILNE-EDWARDS, 1863

Genus *Megapaloelodus* A. H. MILLER, 1944

Megapaloelodus goliath (MILNE-EDWARDS, 1867-71)

F. Phoenicopteridae

Genus *Phoenicopterus* LINNAEUS, 1758*Phoenicopterus croizeti* GERVAIS, 1848-52

O. Anseriformes

F. Anatidae

Genus *Dendrochen* A. H. MILLER, 1944*Dendrochen blanchardi* (MILNE-EDWARDS, 1863)*Dendrochen consobrina* (MILNE-EDWARDS, 1867-71)*Dendrochen natator* (MILNE-EDWARDS, 1867-71)

A new genus, *Mionetta* LIVEZEY & MARTIN 1988, has been created for the species *blanchardi*, and the two other species, *consobrina* and *natator*, are provisionally included in it, but this requires further examination.

Genus *Cygnopterus* LAMBRECHT, 1931*Cygnopterus alphonsi* CHENEVAL, 1984

O. Accipitriformes

F. Accipitridae

Genus *Aquilavus* LAMBRECHT, 1933*Aquilavus depredator* (MILNE-EDWARDS, 1867-71)*Aquilavus priscus* (MILNE-EDWARDS, 1863)Genus *Milvus* LACÉPÈDE, 1799*Milvus deperditus* MILNE-EDWARDS, 1867-71Genus *Promilio* WETMORE, 1958*Promilio incertus* (GAILLARD, 1939)Genus *Palaeohierax* MILNE-EDWARDS, 1867-71*Palaeohierax gervaisii* (MILNE-EDWARDS, 1863)

F. Sagittariidae

Genus *Pelargopappus* STEJNEGER, 1885*Pelargopappus magnus* (MILNE-EDWARDS, 1867-71)

O. Galliformes

F. Quercymegapodiidae MOURER-CHAUVIRÉ, 1992

Still undescribed genus and species (MOURER-CHAUVIRÉ 1992)

F. Phasianidae

Genus *Palaeortyx* MILNE-EDWARDS, 1867-71*Palaeortyx gallica* MILNE-EDWARDS, 1867-71*Palaeortyx brevipes* MILNE-EDWARDS, 1867-71*Palaeortyx phasianoides* MILNE-EDWARDS, 1867-71*Palaeortyx media* MILNE-EDWARDS, 1867-71 (nomen nudum)

O. Gruiformes

F. Rallidae

Genus *Palaeoaramides* LAMBRECHT, 1933*Palaeoaramides christyi* (MILNE-EDWARDS, 1867-71)[syn. *Palaeoaramides eximius* (MILNE-EDWARDS, 1867-71)]Genus *Paraortygometra* LAMBRECHT, 1933*Paraortygometra porzanoides* (MILNE-EDWARDS, 1867-71)

F. Gruidae

Genus *Palaeogrus* PORTIS, 1884*Palaeogrus excelsus* (MILNE-EDWARDS, 1867-71)Genus *Probalearica* LAMBRECHT, 1933*Probalearica problematica* (MILNE-EDWARDS, 1867-71)

F. Otididae (?)

Genus *Otis* LINNAEUS, 1758 (?)*Otis agilis* MILNE-EDWARDS, 1867-71 (nomen nudum)

O. Charadriiformes

F. Recurvirostridae

Genus *Himantopus* BRISSON, 1760*Himantopus brevipes* MILNE-EDWARDS, 1867-71 (nomen nudum)

F. Scolopacidae

Genus *Tringa* LINNAEUS, 1758 (?)*Tringa* sp.Genus *Totanus* BECHSTEIN, 1803*Totanus lartetianus* MILNE-EDWARDS, 1863Genus *Elorius* MILNE-EDWARDS, 1867-71*Elorius paludicola* MILNE-EDWARDS, 1867-71Genus *Calidris* MERREM, 1804*Calidris gracilis* (MILNE-EDWARDS, 1867-71)

F. Burhinidae

Genus *Milnea* LYDEKKER, 1891*Milnea gracilis* LYDEKKER, 1891

F. Laridae

Genus *Larus* LINNAEUS, 1758*Larus desnoyersii* MILNE-EDWARDS, 1863*Larus elegans* MILNE-EDWARDS, 1867-71*Larus totanoides* MILNE-EDWARDS, 1867-71

O. Columbiformes

F. Pteroclididae

Genus *Leptoganga* MOURER-CHAUVIRÉ, 1993*Leptoganga sepultus* (MILNE-EDWARDS, 1867-71)

F. Columbidae

Genus *Gerandia* LAMBRECHT, 1933*Gerandia calcaria* (MILNE-EDWARDS, 1867-71)

O. Psittaciformes

F. Psittacidae

Genus *Archaeopsittacus* LAMBRECHT, 1933*Archaeopsittacus verreauxi* (MILNE-EDWARDS, 1867-71)

O. Strigiformes

F. Tytonidae

Genus *Necrobyas* MILNE-EDWARDS, 1892

Necrobyas arvernensis (MILNE-EDWARDS, 1863)

Genus *Prosybris* BRODKORB, 1970

Prosybris antiqua (MILNE-EDWARDS, 1863)

F. Strigidae

Genus *Bubo* DUMÉRIL, 1806

Bubo poirrieri MILNE-EDWARDS, 1863

O. Apodiformes

F. Apodidae

Genus *Cypseloides* STREUBEL, 1848

Cypseloides ignotus (MILNE-EDWARDS, 1867-71)

O. Coliiformes

F. Coliidae

Genus *Limnatornis* MILNE-EDWARDS, 1867-71

Limnatornis paludicola MILNE-EDWARDS, 1867-71

Limnatornis archiaci (MILNE-EDWARDS, 1867-71)

O. Trogoniformes

F. Trogonidae

Genus *Paratrogon* LAMBRECHT, 1933

Paratrogon gallicus (MILNE-EDWARDS, 1867-71)

O. Coraciiformes

F. Phoeniculidae

Undescribed genus and species (BALLMANN, 1969)

O. Passeriformes

F. Motacillidae

Genus *Motacilla* LINNAEUS, 1758

Motacilla humata MILNE-EDWARDS, 1867-71

Motacilla major MILNE-EDWARDS, 1867-71

F. Laniidae

Genus *Lanius* LINNAEUS, 1758

Lanius miocaenus MILNE-EDWARDS, 1867-71

F. Fringillidae

Genus *Loxia* LINNAEUS, 1758

Loxia sp. 1

Loxia sp. 2

F. Ploceidae

Genus *Passer* BRISSON, 1760

Passer sp.

Genus incertae sedis *Ibidopodia* MILNE-EDWARDS, 1867-71

Ibidopodia palustris MILNE-EDWARDS, 1867-71