the middle of the house. The result of this change was to show, I believe, that the periodic movements indicated by the E.W. level may in part arise from bendings in the walls of the house, caused by the expansion and contraction of the roof.

Referring to the above table, it will be seen that the inclination towards the east changed rather irregularly, in three years being considerable and in the other two slightly retrograde. During the second year of the observations there was an extraordinary movement of $1\frac{1}{2}$ minutes between Nov. 13, 1879, and Jan. 28, 1880, in a direction a little south of east. The masonry on which the levels rested is not, however, totally disconnected from the structure of the house; and it seems to me most probable that the non-periodic movements indicated by the E.W. level are due to a settling of the house in the line of greatest slope of the ground outside.

On the other hand, the change of inclination towards the north has taken place much more regularly, the annual change varying from $0^{\circ}90$ to $2^{\circ}00$, and being $1^{\circ}52$ on an average for the five years.¹ So far as I am aware, there is nothing of a purely local character to account for this movement. It seems to be independent, or nearly so, of that which takes place in an easterly direction; for it may exist without the latter. There can hardly be any creeping of the soilcap or settling of an old house along a line nearly at right angles to that in which the land dips and in reality inclining upwards. It is possible that the levels may be at fault, for, as before remarked, they are by no means perfect instruments; but the regularity of the movements is in favour of the view that they are caused by a real tilting of the ground itself, a tilting which must result in the very slow but still measurable growth of the Lake of Geneva.

VI.—THE GEOLOGICAL DEVELOPMENT, DESCENT AND DISTRIBUTION OF THE MAMMALIA.

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(Continued from page 412, Vol. X. September, 1893.)

IN addition to the localities in Europe and N. America, another area for Tertiary Mammals has in very recent times been laid open to view in the Southern part of Argentina, which promises in the wealth of its contents to exceed those previously known. A few scattered remains from the Tertiary beds of the neighbourhood of Santa Cruz in Patagonia were already known more than forty years ago, but it is only lately, through the work of Burmeister and Moreno, and more particularly through the indefatigable researches of Florentino Ameghino, that a more complete insight into this very remarkable fauna has been obtained. It is imbedded in fresh-water

¹ If this rate were to continue uniform, a change of inclination of ten degrees would be produced in 23,684 years. The rate is, however, probably greater than this; for, since the ground slopes in a direction south of east, movements in this direction affect the inclination of the N.S. level.

deposits, from 60 to 80 mètres in thickness. The following genera are known up to the present from the Santa Cruz Formation :—

MARSUPIALIA.	<i>Analcimorphus.</i>	? <i>Rhadinotherium.</i>
<i>Eodidelphys.</i>	<i>Eucholoeops.</i>	? <i>Palæolithops.</i>
<i>Prodidelphys.</i>	<i>Hyperleptus.</i>	Astrapotherium.
Microbiotherium.	<i>Xyophoros.</i>	? <i>Listriotherium.</i>
<i>Stylognathus.</i>	<i>Planops.</i>	? <i>Astrapodon.</i>
<i>Hadrorkhynchus.</i>	<i>Paraplanops.</i>	Homalodontotherium.
<i>Prothylacinus.</i>	<i>Metopotherium.</i>	? <i>Diorotherium.</i>
<i>Perathereutes.</i>	<i>Eurysodon.</i>	Colpodon.
? <i>Borhyaena.</i>	<i>Tolmodus.</i>	
? <i>Acrocyon.</i>	<i>Prepotherium.</i>	TYPOTHERIA.
? <i>Agustylus.</i>	<i>Lymodon.</i>	Protypotherium.
? <i>Hathlyacinus.</i>	<i>Analcitherium.</i>	Patriarchus.
? <i>Dimamycitis.</i>	<i>Ammotherium.</i>	Interatherium.
? <i>Conodinyctis.</i>		Icochilus.
? <i>Anatherium.</i>		Hegetotherium.
? <i>Sipalocyion.</i>	d. <i>Glyptodontia.</i>	
? <i>Acyon.</i>	Cochlops.	
? <i>Ictioborus.</i>	<i>Eucinepeltus.</i>	RODENTIA.
? <i>Cladosictis.</i>	Propalæohoplophorus.	<i>Steironomys.</i>
? <i>Protoprovierra.</i>	<i>Asterostenma.</i>	Acaremys.
Abderites.		Sciomyss.
Acestias.	e. <i>Dasyopoda.</i>	Scleromys.
<i>Decastis.</i>	Dasyops.	Adelphomys.
Epanorthus.	<i>Chlamydothorium.</i>	Stichomys.
<i>Callomenus.</i>	Peltephilus.	<i>Olenopsis.</i>
<i>Halmadromus.</i>	<i>Stegotherium.</i>	Spaniomys.
<i>Halmasehus.</i>	Prozædyus.	Neoreomys.
<i>Essoprion.</i>	Proeutatus.	<i>Hedimys.</i>
<i>Pichipilus.</i>	? <i>Antiesodon.</i>	<i>Phanomys.</i>
<i>Garsonia.</i>		Eocardia.
<i>Halmariphus.</i>		? <i>Procardia.</i>
EDENTATA.	PERISSODACTYLA.	? <i>Dicardia.</i>
a. <i>Vermilinguia.</i>	a. <i>Proterotheridæ.</i>	? <i>Tricardia.</i>
<i>Scotæops.</i>	Diadiophorus.	<i>Schistomys.</i>
b. <i>Tardigrada.</i>	Licaphrium.	<i>Sphaeromys.</i>
<i>Entelops.</i>	Thoatherium.	<i>Sphodromys.</i>
<i>Dideilootherium.</i>	Proterotherium.	<i>Sphingomys.</i>
c. <i>Gravigrada.</i>		Perimys.
<i>Zamicrus.</i>	b. <i>Macrauchenidæ.</i>	<i>Pliolagostomus.</i>
Hapalops.	Theosodon.	Prolagostomus.
<i>Pseudhapalops.</i>	<i>Cælosoma.</i>	<i>Lagostomus.</i>
<i>Amphikahalops.</i>	<i>Pseudocælosoma.</i>	<i>Scotoemys.</i>
<i>Schismootherium.</i>	TOXODONTIA.	
<i>Trematherium.</i>	Nesodon.	PRIMATES.
<i>Nematherium.</i>	Adinotherium.	<i>Homunculus.</i>
<i>Geronops.</i>	? <i>Gronotherium.</i>	? <i>Homocentrus.</i>
	? <i>Xotoprotodon.</i>	<i>Anthropops.</i>
	? <i>Acrotherium.</i>	? <i>Eudiasatus.</i>
	? <i>Phoberootherium.</i>	
	? <i>Nannodus.</i>	

The composition of this Patagonian Tertiary fauna, which according to Ameghino is preceded by some older mammalian remains, intermingled with some probably Dinosaurian and Crocodile bones, stands in the strongest contrast with the Mammalia occurring in the Eocene of Europe. Of the 121 genera introduced above, with at least 220 species, a notable proportion will very likely not stand critical examination, but in any case the fossil mammalian fauna of Santa Cruz notably exceeds, in its wealth of genera and species, that

now existing in Argentina, which according to Ameghino only contains 107 species, and it is in this point of view equally comparable with that of the Upper Eocene of Europe. Ameghino increases the list further by three alleged Amblypoda (*Planodus*, *Adelotherium*, *Adrastotherium*) and a Tillodont (*Entocasmus*), but these additions are based on remains which absolutely do not permit of satisfactory determination. In comparison with the Europeo-American Eocene fauna, the complete absence of the Artiodactyla, Insectivora, Chiroptera, Carnivora and Prosimiæ, is very striking. The Perissodactyla are represented by two entirely novel extinct families (Proterotheridæ and Macrauchenidæ); the Rodents entirely by Hystricomorphous forms of a specifically South American type, and equally so the Primates by the Platyrrhine Apes. The fauna is mainly composed of Marsupials, Edentates, Toxodonts and Typotheria. Only South America possesses representatives of these two last orders, which make their appearance in the Santa Cruz formation and become extinct in the Pampas formation. Also all the forms of Edentates belong to the Xenarthra, which now live exclusively in South America, and amongst the Marsupials, the most prominent are the Didelphyidæ, which still live all over America and in the Tertiary period were distributed over the Northern hemisphere, but these are accompanied by other forms of the same order which show an Australian stamp. Ameghino has placed these in part with the Dasyuridæ and in part with the Creodontia, but as regards the last he is now himself doubtful, and acknowledges¹ that a part at least of the supposed Creodontia may belong to the Marsupials. The same may be said of the supposed Plagiaulacidæ, on which Ameghino had mainly relied to determine the age of the Santa Cruz formation.² These also probably form an independent family of Marsupials, either indigenous or possibly migrated from Australia.

Under any circumstances South America must be considered as an independent "centre of creation," which possibly at an early period had been ingrafted from Australia, but which already in the Santa Cruz formation had produced peculiar forms of Marsupials. In favour of a connection with the mammalian fauna inhabiting Europe and North America at the same time, there is, in spite of the assurances of Ameghino, no ground of support. On the other hand it cannot be denied that there is some authority for the supposition of Ihering, based on the distribution of the fresh-water animals, that South America, during the Mesozoic and Older Tertiary periods, was connected by land with Australia and South Africa. The associated

¹ Revista Argentina, I. p. 314.

² The examination of a great number of lower jaws and detached teeth of the genera *Aberites*, *Acdestis* and *Epanorthus*, which I owe to the kindness of Señor Ameghino, shows that the molars in these genera do not agree, either in number or in form, with those of *Neoplagiaulax*. They greatly resemble those of the Australian *Hypsiprymnidæ*, and they are proved to be genuine Marsupials by the incurved angle of the lower jaws. Ameghino also acknowledges them (Revue génér. des Sciences, 1893, p. 77) as Diprotodont Marsupials, to which he also further assigns *Plagiaulax*, *Neoplagiaulax* and *Ptilodus*.

group of animals which the investigations of Ameghino has brought to light in Patagonia is new and altogether peculiar, and in it are to be found the ancestors of the Edentates, Rodents and Apes of the present neotropical kingdom.

There are great difficulties in the way of precisely determining the age of a fauna thus new and circumscribed, more particularly since the geological relations do not yield any definite information. The Santa Cruz beds rest directly on the "Guaranian formation," the lower portion of which consists of marine deposits, undoubtedly belonging to the Cretaceous; whilst the upper consists of conglomerates and coarse sandstones, in which the remains of Opisthocœlous Crocodiles and Dinosaurs (?) and the imperfectly preserved mammalian fragments mentioned above (*Macropristis*, *Pyrrhotherium*, etc.) have been discovered. The Santa Cruz formation is overlaid by flows of Basalt, and it forms the foundation for the marine deposits with *Ostræa Patagonica*, *Pecten Paranensis*, and a great number of other fossil shells which have been already examined by D'Orbigny, Darwin and Bravard, and determined to be Tertiary. Darwin held the marine deposits to be Eocene, D'Orbigny, Miocene, and Ameghino, Oligocene. Direct points of comparison with North American or European Tertiary strata are here also wanting, so that the age of the Santa Cruz and Patagonian formations must be wholly determined from the general character of the fossil remains.

Ameghino places the mammalian fauna of Santa Cruz in the Eocene. That, however, the existence of Amblypoda, Tillodontia, Creodontia, and Plagiaulacidæ cannot be advanced in favour of this view, has already been mentioned. Amongst the Marsupials, forms of a distinctly ancient stamp are wanting, and in particular one fails to find close ties to the Mesozoic Polyprotodontidæ and Allotheria. Amongst the Perissodactyla, the Macraucheniidæ stand on a primitive rank as regards their dentition and the structure of their extremities, when compared with their later successors in the Pampas formation; on the other hand the Proterotheridæ, which, as regards their dentition, may be the most readily compared with the Anoplotheridæ and Palæotheridæ, have far outran these latter in the reduction of the lateral metapodials and in the complete differentiation of the extremities. The remarkably numerous and varied Edentates do not in the least correspond with the ideas which one is justified in holding respecting the ancestors of this order. They remain, indeed, in size far behind the giant forms of the Pampas formation, but they are already just as distinctly divided into sub-orders (*Vermilinguia*, *Tardigrada*, *Gravigrada*, *Glyptodontia* and *Dasypoda*) as in the Pleistocene, and they stand in all the important features of the dentition and build of the skeleton, on a high grade of differentiation. The molars are already of a prismatic form, incisor teeth are only known in two genera, and a change of teeth appears to have taken place just as seldom as in the majority of living Edentates. Skull and skeleton do not materially differ from those of younger genera, and the characteristic dermal shields of the Glyptodonts and Dasypoda from the Santa Cruz formation are in reality built up like

those of Pleistocene and living genera. According to Ameghino even two existing genera (*Dasypus* and *Chlamydothorium*) make their appearance in the Santa Cruz formation. The Edentates cannot, therefore, be appealed to as witnesses for the ancient character of the fauna. Just as little can the Rodents. These also belong exclusively to Hystricomorphous forms of a specifically South American stamp, and they are in part very closely connected with genera still living or even altogether identical with them (as *Lagostomus*). Their supposed relations to the European Protrogomorpha (*Theridomys*, *Nesokerodon*, *Archæomys*) have proved deceptive, and the same is also the case with regard to the North American Tertiary Rodents. The mostly high prismatic teeth and the absence of a milk dentition are proofs that the Rodents of the Santa Cruz formation have on the whole reached a higher grade of development than their Upper Eocene relatives in Europe and North America. Amongst the Toxodonts only the Homalodontotheriidae show primitive features; all the rest have a highly differentiated dentition, mostly prismatic molars and reduced extremities. In the Typotheria the generally closed rows of teeth and the five-toed extremities betray a more primitive condition than in their successors of the Newer Tertiary and of the Pampas formation, but even in this group the curved molars have already reached a prismatic form. Finally, the Apes can in no wise be considered as the stock from which all our present Simiæ have descended, for they have a definite South American stamp, and, as regards differentiation, they stand markedly above the more generalised Pachylemuridae of the European and North American Tertiaries.

Taken all in all, the Santa Cruz fauna has distinctly reached a higher rank than the mammalian groups in the Lower and Middle Eocene of the Northern hemisphere. It can, at the furthest, be placed on a parallel with the Upper Eocene or with the Oligocene of Europe.

OLIGOCENE.

The coal-bearing Lower fresh-water Molasse of the North and South Alps (Upper Bavaria, Switzerland, near Vicenza, Cadibona and Zovencedo in Liguria) and of the Waadtländer highlands (Rochette, near Lausanne); the contemporaneous deposits in Hungary (Gran) and Dalmatia (Monte Promina); the marine sands and brackish marls of the Mayence basin; of the Upper Rhine valley (Lobsann); of the neighbourhood of Paris (Fontainebleau, Etampes); the fresh-water marl of Ronzon near Le Puy, Villebramar, St. Henri, Manosque, and other places in the South of France, and the lacustrine deposits of Hempstead and Colwell Bay in the Isle of Wight, contain a scanty mammalian fauna composed of the following genera:—

MARSUPIALIA.

Didelphys.

Amphiperatherium.

PERISSODACTYLA.

Aceratherium.

? *Ronzotherium*.

ARTIODACTYLA.

Anthracootherium.

Ancodus.

Elotherium.

Plesiomyx.

Gelocus.

RODENTIA.

Theridomys.

Cricetodon.

? *Dacticus*.

? *Elomys*.

INSECTIVORA.
Tetracus.

CREODONTIA.
Hyænodon.

CARNIVORA.
Cynodon.
Amphicyonodon.
Plesictis.
? *Elocyon*.

SIRENIA.
Halitherium.

CETACEA.
? *Squalodon*.
? *Balenoptera*.

The Oligocene mammalian fauna only maintains any claim to independence through the abundant occurrence of *Anthracotherium*, *Ancodus* and *Elotherium*. It shares nearly all its genera with the Upper Eocene, of which it shows itself an impoverished descendant. The absence of a considerable number of genera flourishing in the Upper Eocene is worthy of note (*Anoplotherium*, *Diplobune*, *Xiphodon*, *Palæotherium*, *Paloplotherium*, *Anechilophus*, *Pterodon*, *Proviverra*, etc.).

MIocene.

I. The fresh-water deposits, referred to the Lower Miocene, of Limagne (St. Gérard-le-Puy, Cournon, Gannat, etc.), of the Paris basin (Calcaire de Beauce), of the neighbourhood of Mayence (Weisenau, Hochheim, Mombach), Ulm (Haslach, Eckinggen, Michelsberg, Eselsberg) contain a tolerably rich and characteristic mammalian fauna which, unfortunately, has only been discovered in a few European localities. It consists of the following genera:¹—

MARSUPIALIA.
† *Didelphys*.
(*Oxygomphius*).
† *Amphiperatherium*.

PERISSODACTYLA.
* *Tapirus*.
Aceratherium.
* *Rhinoceros*.
(*Diceratherium*).
? *Macrotherium*.

ARTIODACTYLA.
† *Anthracotherium*.
† *Palæochoerus*.
*† *Amphitragulus*.
† *Dremotherium*.
† *Cænotherium*.
† *Plesiomeryx*.

RODENTIA.
† *Theridomys*.
*† *Archæomys*.
*† *Issiodoromys*.
* *Myoxus*.
Cricetodon.
* *Spermophilus*.
Sciurus.
* *Steneofiber*.
*† *Titanomys*.

INSECTIVORA.
* *Talpa*.
*† *Geotrypus*.
*† *Echinogale*.
* *Myogale*.
*† *Plesiosorex*.
Sorex.
* *Dimylus*.
*† *Cordylodon*.
*† *Palæoerinaceus*.
* *Erinaceus*.

CHEIROPTERA.
† *Palæonycteris*.
? *Vespertilio*.

CREODONTIA.
† *Hyænodon*.

CARNIVORA VERA.
(*Fissipedia*).
† *Cephalogale*.
* *Amphicyon*.
Stenogale.
† *Plesictis*.
† *Palæogale*.
* *Potamotherium*.
† *Amphictis*.
Viverra.
* *Herpestes*.
* *Proælorus*.

At the first glance this fauna can be recognized as a descendant also of the Upper Eocene and Oligocene faunas. The same orders, and frequently also the same genera, are repeated in all three, and the percentage division of the particular orders shows also considerable uniformity. In the absence of Lemurs, in the marked decline and final extinction of the Marsupials, Creodontia and Anoplotheridæ, in the much greater abundance of particular genera which were of only sporadic occurrence at an earlier period, such as *Anthracotherium*,

¹ The genera marked with * appear for the first time; those with † become extinct, and those marked *† appear in the Lower Miocene and likewise die out in the same.

Palæochærus and *Dremotherium*, and in the springing up of a considerable number of new genera, as *Tapirus*, *Diceratherium*, *Amphitragulus*, *Steneofiber*, *Titanomys*, *Erinaceus*, *Dimylus*, *Amphicyon*, *Potamotherium*, *Herpestes*, *Proclurus*, and others, depend the differences between the Upper Eocene, the Oligocene and the Lower Miocene faunas of Europe. Amongst the new genera there is, further, no single form for which a corresponding related form could not be found in the Eocene; only in the modification, differentiation and improvement of the older types is the new fauna distinguished from the earlier one. With the exception of some Marsupials, Rodents, Insectivora and Bats (*Didelphys*, *Myoxus*, *Cricetodon*, *Spermophilus*, *Sciurus*, *Talpa*, *Myogale*, *Sorex*, *Erinaceus*, *Vespertilio*), all the larger genera are extinct.

The rich mammalian fauna of the so-called White-River beds, which in North Nebraska, Dakota, Colorado, Wyoming and South Canada cover a very extended area, and reach a thickness of from 40—60 mètres, holds an altogether similar relationship to the Bridger and Uinta fauna, as the fauna of the Lower Miocene of Europe to that of the Upper Eocene and Oligocene. The powerful Amblypoda and the peculiar Tillodontia are extinct, the Creodontia are shrunk up to a single genus (*Hyænodon*); the Prosimiæ are, however, still represented by two genera. For the rest, the White-River fauna consists of Marsupials, Perissodactyla, Artiodactyla, Rodents, Insectivora, Bats, and genuine Carnivora, and the following genera are present in it:¹—

MARSUPIALIA.	ARTIODACTYLA.	INSECTIVORA.
Didelphys.	*† <i>Ancodus</i> (E.)	† <i>Ictops.</i>
	*† <i>Elotherium</i> (E.)	*† <i>Leptictis.</i>
	*† <i>Percharus.</i>	*† <i>Mesodectes.</i>
	*† <i>Leptochærus.</i>	*† <i>Geolabis.</i>
	*† <i>Agriochærus.</i>	
PERISSODACTYLA.	*† <i>Oreodon.</i>	CHIROPTERA.
*† Meshippus.	*† <i>Poebrotherium.</i>	*† <i>Domnina.</i>
*† <i>Tapiravus.</i>	*† <i>Gomphotherium.</i>	
*† <i>Aceratherium</i> (E.)	*† <i>Leptomeryx.</i>	CREODONTIA.
*† <i>Hyracodon.</i>	*† <i>Hypisodus.</i>	*† <i>Hyænodon</i> (E.)
*† <i>Metamynodon.</i>	*† <i>Hypertragulus.</i>	
*† Titanotherium.	*† <i>Protoceras.</i>	CARNIVORA VERA.
(<i>Diconodon.</i>		(Fissipedia.)
<i>Brontops.</i>	RODENTIA.	
<i>Brontotherium.</i>	*† <i>Ischiromys.</i>	*† <i>Daphænos.</i>
<i>Menops.</i>	*† <i>Steneofiber</i> (E.)	*† <i>Galeocynus.</i>
<i>Symborodon.</i>	*† <i>Heliscymys.</i>	*† <i>Hoplophoneus.</i>
<i>Megacerops.</i>	*† <i>Gymnoptychus.</i>	*† <i>Dinictis.</i>
<i>Titanops.</i>	*† <i>Eumys.</i>	PRIMATES.
<i>Allops.</i>	*† <i>Palæolagus.</i>	*† <i>Laopithecus.</i>
<i>Dalodon.</i>		*† <i>Menotherium.</i>
<i>Teleodus.</i>		

Amongst the Perissodactyla, *Meshippus* represents only a somewhat more advanced stage of differentiation of *Epishippus*, and exactly in the same manner *Tapiravus* is related to *Helaletes*, *Hyracodon* to *Hyrachyus*, *Metamynodon* to *Amyndon*. The Titanotheridæ, with an

¹ The genera to which the letter (E.) is affixed occur also in the Miocene of Europe. For the other marks see the note on p. 460.

abundance of species, form, by their gigantic dimensions and their great numbers, a highly characteristic element of the White-River fauna, and they are plainly descended from the Eocene Palæopsinæ. Amongst the Artiodactyla, the Oreodontidæ (*Agriochærus*, *Oreodon*), as regards their abundance, take the first place; they are also already represented in the Uinta beds by *Protoreodon*; in a like manner *Poebrotherium* and *Gomphotherium* show that they are progressive connecting links between the existing Camels and the Eocene Leptotragulidæ. The micro-fauna of the White-River beds is also closely connected with that of the Eocene; on the other hand, the genuine Carnivora, the Tragulidæ (*Leptomeryx*, *Hypisodus*, *Hypertragulus*), the remarkable cervine genus *Protoceras*, as also some genera which have probably migrated from Europe (*Aceratherium*, *Ancodus*, *Elotherium*, *Steneofiber*, *Hyænodon*), stand forth as new forms. It is evident that there was still intercourse between Europe and North America, but whilst in the Older Eocene the new world made a present of its superfluity to Europe, in the Miocene period North America received a greater number of immigrants from Europe.

II. In the Newer Miocene period the area of distribution of the terrestrial mammals in Europe became notably extended. The district between the Alps and the Jura-plateau, heretofore covered by the sea, was now laid dry, or sprinkled over with fresh-water lakes and bogs; in the Vienna basin also the sea is receding, in the Alps (Steiermark) and on the Jura-plateau (Steinheim, Nördlingen, Georgensgmünd) the depressions are filled up with fresh-water and contain the washed-in remains of land animals. A number of localities in the Rhone valley (Grive-St.-Alban), in Switzerland (Winterthur, Käpfnach, Elgg, Chaux-de-Fonds, Vermes), in Upper-Baden (Eningen, Engelswies, Heudorf), on the Swabian-Bavarian high-plateau (Kirchberg, Günzburg, Dinkelscherben, Haeder, Dachau, Munich, Freising, Lower Bavaria), on the Jura-plateau, in the Vienna basin, Steiermark, Hungaria, Roumania, and Bessarabia contain the remains of land mammals, which also are again found to the west of the Central-plateau of France, in the former Aquitanian basin, now deserted by the sea (Sansan, Simorre, St. Gaudens), in Touraine and in the Orléanais, and they have also been discovered in Spain (San Isidro) and Algeria. Italy (Monte Bamboli) has at least yielded traces of the same. The Newer or Middle Miocene fauna consists of the following genera:—

PERISSODACTYLA.	<i>*Hyæmoschus.</i>	RODENTIA.
<i>*†Anchitherium.</i>	(<i>Dorcatherium.</i>)	<i>Sciurus.</i>
<i>Tapirus.</i>	<i>*†Palæomeryx.</i>	<i>Steneofiber.</i>
<i>Aceratherium.</i>	<i>*Procervulus.</i>	<i>Cricetodon.</i>
<i>Rhinoceros.</i>	<i>*†Micromeryx.</i>	<i>Myoxus.</i>
(<i>Dihoplus.</i>)	<i>*†Dicroceras.</i>	<i>*Hystrix.</i>
<i>†Macrotherium.</i>	<i>*†Protragoceras.</i>	<i>*Myolagus.</i>
		<i>*Lagomys.</i>
ARTIODACTYLA.	PROBOSCIDA.	
<i>*†Hyootherium.</i>	<i>*Mastodon.</i>	INSECTIVORA.
<i>*Charotherium.</i>	<i>*Dinothereum.</i>	<i>Talpa.</i>
<i>*†Listriodon.</i>		<i>*†Galerix.</i>

¹ See note on p. 460.

*† <i>Lanthanotherium</i> .	CARNIVORA.	*† <i>Trochictis</i> .
<i>Myogale</i> .	(Fissipedia.)	*† <i>Trochotherium</i> .
<i>Erinaceus</i> .	*† <i>Galecyne</i> .	* <i>Enhydriodon</i> .
<i>Sorex</i> .	† <i>Amphicyon</i> .	<i>Viverra</i> .
<i>Crociodura</i> .	*† <i>Pseudocyon</i> .	<i>Herpestes</i> .
† <i>Dimylus</i> .	*† <i>Hemicyon</i> .	*† <i>Frognetta</i> .
	*† <i>Dinocyon</i> .	† <i>Pseudelurus</i> .
CHIROPTERA.	* <i>Hyænarcos</i> .	* <i>Machairodus</i> .
<i>Vespertilio</i> .	*† <i>Haplogale</i> .	
<i>Vesperugo</i> .	† <i>Stenogale</i> .	PRIMATES.
	*† <i>Pseudictis</i> .	*† <i>Dryopithecus</i> .
	† <i>Palæogale</i> .	*† <i>Pliopithecus</i> .
	*† <i>Propulorius</i> .	*† <i>Oreopithecus</i> .
	* <i>Mustela</i> .	

The sudden appearance of Proboscidiæ (*Mastodon*, *Dinotherium*) and of genuine Apes (*Dryopithecus*, *Pliopithecus*, *Oreopithecus*), the abundance of *Rhinoceros* and *Anchitherium*, the first occurrence of horned Ruminants (*Dicoceras*, *Procervulus*) and Antelopes (*Protragoceras*), the great development of carnivorous animals which, in their organization, are intermediate between dogs and bears, give to the fauna of the Middle Miocene a stamp fairly distinct from that immediately preceding it, and this is more intensified by the absence of small Cænotheria and Creodontia. The gap between the Middle Miocene and the Lower Miocene fauna is certainly a much larger one than that between this latter and the Upper Eocene fauna. No single species from the Lower Miocene has been preserved unchanged, and even the genera which have continued on from the earlier epoch belong, with the exception of *Aceratherium*, *Rhinoceros*, *Viverra*, *Herpestes*, and *Stenofiber*, to the Insectivora, Rodents, Bats and small Carnivora, which are well known to be only slightly subject to modification. Also the genera of that period, which are still in existence, are, with the exception of *Tapirus*, *Rhinoceros*, *Viverra*, and *Herpestes*, representatives of the micro-fauna, and they mostly have at the present time a cosmopolitan distribution. Of the four genera of the larger forms, *Tapirus* lives in India and South America, the three others in the Mediterranean region, Africa and South Asia, thus altogether in strikingly extensive areas of distribution.

The remarkable difference in the mammalian faunas of the Lower and Middle Miocene receives an explanation when it is considered that between them there are interposed, almost everywhere in Europe, thick marine deposits, which must, under any conditions, represent a long period of time, and these only contain remains of marine animals, and yield no information respecting the occupiers of the land in the same interval. The Miocene Thalassotheriæ all belong to extinct genera of Cetacea, Sirenia and Pinnipedia, concerning whose origin complete darkness prevails, as is likewise the case with their scanty forerunners in the Eocene (*Zeuglodon*, *Prorostomus*, *Haliitherium*). That the shores of Europe and North America were inhabited by similar marine mammals in the Tertiary period follows, moreover, from the wide distribution of certain genera (*Zeuglodon*, *Squalodon*), and from the general agreement in character

of the fossil Cetacea in the Miocene of Europe and in that of the United States (New Jersey, Maryland, Virginia, Georgia, Carolina). These contain the following genera :—

EUROPE.		NORTH AMERICA.
CETACEA.		CETACEA.
Squalodon.	SIRENIA.	? <i>Delphinodon.</i>
Champsodelphis.	Halitherium.	? <i>Phocogeneus.</i>
<i>Trachyacanthus.</i>	<i>Rhytiodus.</i>	Squalodon.
<i>Delphinopsis.</i>	Metazytherium.	<i>Zarhachis.</i>
<i>Heterodelphis.</i>	<i>Miosiren.</i>	<i>Ixacanthus.</i>
<i>Priscodelphinus.</i>	<i>Prohalicore.</i>	<i>Cetophis.</i>
Schizodelphis.	CARNIVORA.	<i>Lophocetus.</i>
<i>Macrochirifer.</i>	(Pinnipedia.)	Priscodelphinus.
? <i>Cetorhynchus.</i>	<i>Pristiphoca.</i>	<i>Rhabdosteus.</i>
<i>Beluga.</i>	<i>Monatherium.</i>	<i>Agabelus.</i>
<i>Physodon.</i>	<i>Prophoca.</i>	Balænoptera.
Hoplocetus.	<i>Mesotaria.</i>	
<i>Plesiocetus.</i>		SIRENIA.
Cetotherium.		? <i>Hemicaulodon.</i>

For the Middle Miocene land mammalian fauna also there is not wanting a parallel in North America. Hitherto only the extreme West, in the territories of Oregon, Nevada and Washington, has yielded those remains, in part so wonderfully preserved, which compose the John-Day fauna. The abundant occurrence of *Rhinoceros*, *Aceratherium*, *Anchitherium*, *Steneofiber*, *Sciurus*, *Lepus* and *Galecynus* shows that European genera could, at that time, still wander to the Pacific Ocean, and even although certain specifically American families, like the Oreodontidæ and the Camelidæ, have experienced a further evolution and increase in number, there are, nevertheless, not wanting representative forms from which a common origin and the former connection of both continents may be inferred. To the oldest horn-bearing mammal in Europe (*Dicroceras*) corresponds in North America *Blastomeryx*, to the remarkable Macrotheriæ and Chalicotheriæ of the old world, the American genus *Moropus*, and also between the Rodents and Carnivora of both continents there are many related links, although the lists mostly contain other names, which, however, mainly indicate similar forms. The fauna of the John-Day beds contains the genera mentioned below :¹—

PERISSODACTYLA.	<i>Agriochærus.</i>	CARNIVORA.
Anchitherium (E.)	Merycochærus.	(Fissipedia.)
Aceratherium (E.)	Blastomeryx.	Temnocyon.
Rhinoceros.		Galecynus (E.)
(<i>Diceratherium</i>) (E.)	RODENTIA.	<i>Hyænocyon.</i>
<i>Moropus.</i>	Allomys.	Oligobunus.
	<i>Sciurus</i> (E.)	<i>Enkydrocyon.</i>
ARTIODACTYLA.	Steneofiber (E.)	Nimravus.
<i>Boöcherus.</i>	<i>Pleurolicus.</i>	Pogonodon.
Chænohyus.	<i>Entoptychus.</i>	Archæolurus.
<i>Bothrolabis.</i>	Hesperomys.	Hoplophoneus.
? <i>Thinohyus.</i>	<i>Paciculus.</i>	
<i>Coloreodon.</i>	Palæolagus.	
	<i>Lepus</i> (E.)	

¹ The genera to which the letter (E.) is affixed occur also in Europe.

The outlines of the Newer Miocene fauna of North America have been extended by the discoveries in the so-called Deep-River or *Ticholeptus* beds, which are at present known only in Western Nebraska, in the valley of Deep-River in Montana, and in Cotton-Wood Creek, Oregon. The fauna of these deposits is of a somewhat newer stamp than that of the John-Day beds. It is especially distinguished by the occurrence of *Mastodon*, by the great development of the Oreodontidæ (*Merycochoærus*, *Merychys*, *Leptauchenia*, *Cyclopidius*, *Pitheciustus*) and Camelidæ (*Protolabis*) and by the continuance of *Anchitherium* and *Blastomeryx*. Altogether about 20 species are known from this horizon.

III. In Europe, also, at the close of the Miocene, a fairly radical change in the character of the land mammals takes place. The localities which disclose to us the Uppermost Miocene fauna are relatively few, and mostly widely apart from each other, but some of them are distinguished by the astonishing abundance and the excellent preservation of the remains which are found in them. Thus, for example, at Pikermi, near Athens, from an area of 300 m. in length and 60 m. in width, no fewer than 40 species of mammals have been dug up, and some of these are represented by hundreds of individuals, whilst some of the skeletons are entire. A similar necropolis of ancient mammals has been discovered in Samos, and another at Mount Léberon in Provence. Various localities in the Rhone valley, at the foot of the Pyrenees, in Spain, Algeria, and in Asia-Minor, show that the Pikermi fauna was widely distributed in the Mediterranean region. It is not altogether absent in the countries north of the Alps, but it is there somewhat poorer, it lacks, in particular, certain forms of Ruminants (Antilopidæ, Giraffidæ) which in the south were evidently surrounded by rich grass-bearing Steppes, and these are replaced by forest-loving Deer. The renowned sand-deposits of Eppelsheim near Worms, the Belvedere gravels near Vienna, and the widely-distributed Congeria beds of the Pontis division, in the Vienna basin, Hungaria and Roumania, contain the remains of the Uppermost Miocene fauna which by many authors is referred to the Pliocene. It is composed of the following genera :—¹

EDENTATA.	(<i>Dorcatherium</i> .)	PROBOSCIDIA.
* <i>Orycteropus</i> .	<i>Cervulus</i> .	Mastodon.
	*† <i>Palæotragus</i> .	† <i>Dinotherium</i> .
PERISSODACTYLA.	*† <i>Samotherium</i> .	
*† <i>Hipparion</i> .	*† <i>Helladotherium</i> .	RODENTIA.
<i>Tapirus</i> .	* <i>Camelopardalis</i> .	† <i>Steneo fiber</i> .
<i>Aceratherium</i> .	*† <i>Tragoceras</i> .	*† <i>Acomys</i> .
<i>Rhinoceros</i> .	*† <i>Palæoryx</i> .	Hystrix.
(<i>Dihoplus</i> .)	*† <i>Tragelaphus</i> .	
*† <i>Leptodon</i> .	*† <i>Palæoreas</i> .	INSECTIVORA.
? <i>Titanotherium</i> .	*† <i>Antidorcas</i> .	<i>Sorex</i> .
*† <i>Chalicotherium</i> .	* <i>Gazella</i> .	
	Antilope.	CARNIVORA.
ARTIODACTYLA.		(<i>Fissipedia</i> .)
* <i>Sus</i> .		*† <i>Simocyon</i> .
Hyæmoschus.		

¹ See note on p. 460.

CARNIVORA, cont.	*† <i>Promephitis</i> .	* <i>Felis</i> .
† <i>Amphicyon</i> .	*† <i>Ictitherium</i> .	Machairodus.
† <i>Hyenarctos</i> .	*† <i>Lycyæna</i> .	
<i>Mustela</i> .	*† <i>Hyenictis</i> .	PRIMATES.
*† <i>Promeles</i> .	* <i>Hyæna</i> .	*† <i>Mesopithecus</i> .

The strangest constituent of this fauna is the Edentate genus *Orycteropus*, an African type which has maintained itself in the Southern hemisphere of the old world up to to-day. Also amongst the Ruminants, the Giraffes, Gazelles, and numerous Antelopes point to African connections, and they confirm the view that at that time there was a land junction between the Mediterranean region and the dark continent, over which herds of Ruminants traversed. Amongst these far-advanced, almost modern, types, *Helladotherium* and *Samotherium* stand out as relicts of an older period, and also *Mastodon*, *Dinotherium*, *Tapirus*, *Aceratherium*, *Rhinoceros*, *Chalicotherium* (which only differs slightly from *Macrotherium*), *Hyæmoschus*, *Cervulus*, *Steneofiber*, *Hystrix*, *Mustela* and *Sorex* support the continuity with the preceding Miocene fauna. Troops of a slim zebra-like horse (*Hipparion*) and genuine wild pigs of notable size inhabited at that time almost all Europe, and the abundance of wild game had a corresponding influence on the development of the Carnivora. Hyænas, Cats with powerful teeth (*Machairodus*), Civet-cats (*Ictitherium*), and the forerunners of Bears (*Simocyon*, *Amphicyon*, *Hyenarctos*) have yielded abundant remains, and they exceed in number the smaller genera (*Mustela*, *Promeles*, *Promephitis*) which have partly been taken over from the Middle Miocene. If there yet remained any hesitation as to the tropical character of this fauna, the occurrence in it of an Ape nearly related to the living *Semnopithecus*, of which dozens of skulls and entire skeletons have been dug up at Pikermi, would remove all doubt. Although the number of still existing races is not much greater than in the Middle Miocene, yet the Upper Miocene fauna wears a distinctly more modern dress, and in several groups it has already almost reached the standard of the existing fauna.

For the determination of the former distribution of the mammalia the discoveries made in different parts of Asia possess a high interest. From the renowned localities in the Sivalik Hills, at the southern foot of the Himalayas, between the Ganges and the Sutlej, Falconer and Cautley had already by the middle of this century reaped a rich harvest; traces of this fauna were shown by the brothers Schlagintweit to be present in Thibet; and also the valleys of the Indus and the Narbudda, and the Island of Perim, in the Gulf of Cambay, further Ava in the Irrawaddy basin, Burma, Java, Sumatra, the Philippines, China and Japan have yielded some sparse remains which speak in favour of an extraordinarily wide distribution of the Sivalik fauna in Southern and Eastern Asia. Through the discoveries in Persia (Maragha) and Asia-Minor (Lake Urmia, Troy), this fauna is brought in direct connection with Europe.

The so-called Sivalik fauna is not of a single independent character, for it clearly contains forms which correspond to those in the European Middle and Upper Miocene and the Older Pliocene. A distinct

division into geological horizons cannot, unfortunately, at present be carried out. Nevertheless, Lydekker considers that certain localities in Sind, Cutch, on the Island of Perim, and in the Sivalik Hills specially contain older types, and others Pliocene forms. The entire fauna consists of about 150 species, which are divided amongst the following genera:—¹

PERISSODACTYLA.	Camelopardalis (E.)	<i>Rhizomys</i> .
Hipparion (E.)	Helladotherium (E.)	<i>Hystrix</i> (E.)
? <i>Hippodactylus</i> .	<i>Vishnutherium</i> .	<i>Lepus</i> (E.)
Equus (E.*)	Sivatherium .	
? <i>Tapirus</i> (E.)	<i>Hydasphitherium</i> .	CARNIVORA.
Aceratherium (E.)	Bramatherium .	(Fissipedia.)
Rhinoceros (E.)	<i>Alcelaphus</i> .	<i>Amphicyon</i> (E.)
(<i>Atelodus</i> .)	<i>Tetraceras</i> .	Canis (E.*)
(<i>Cerutorhinus</i> .)	? <i>Cobus</i> .	Hyenarctos (E.)
Chalicotherium (E.)	Gazella (E.)	<i>Ursus</i> (E.*)
	<i>Hippotragus</i> .	Mustela (E.)
ARTIODACTYLA.	<i>Boselaphus</i> .	Mellivora .
Anthracotherium (E.)	<i>Oreas</i> .	<i>Mellivorodon</i> .
<i>Merycopotamus</i> .	Strepsicerass .	Lutra (E.)
<i>Chæromeryx</i> .	Capra .	Enhydriodon (E.)
<i>Hemimeryx</i> .	<i>Bucapra</i> .	Viverra (E.)
<i>Listriodon</i> (E.)	? <i>Ovis</i> .	<i>Lepthyæna</i> .
<i>Hippohys</i> .	Leptobos (E.*)	Hyæna (E.)
Sus (E.)	Bubalus (E.*)	<i>Æluropsis</i> .
<i>Sanitherium</i> .	<i>Bison</i> (E.*)	<i>Ælurogale</i> .
<i>Hyotherium</i> (E.)	Bos (E.*)	Felis (E.)
<i>Tetraconodon</i> .		Machairodus (E.)
Hippopotamus (E.)	PROBOSCIDA.	
<i>Camelus</i> .	Mastodon (E.)	PRIMATES.
<i>Dorcatherium</i> (E.)	Dinotherium (E.)	Cynocephalus .
<i>Tragulus</i> .	Elephas (E.*)	<i>Macacus</i> (E.*)
? <i>Moschus</i> .		Semnopithecus (E.*)
<i>Palæomeryx</i> (E.)	RODENTIA.	<i>Trogodytes</i> .
<i>Cervus</i> (E.)	<i>Nesokia</i> .	<i>Simia</i> .

The agreement of the Sivalik fauna with that of Pikermi, Samos, Léberon, etc., in Europe, is not confined to a very considerable number of common genera but is extended even to the identity of several species. Even if a few remarkable types like *Sivatherium*, *Vishnutherium* and *Bramatherium*, are, up to the present, unknown in Europe, yet the total character of the Upper Miocene mammalian fauna in Europe, North Africa, Asia-Minor, South and East Asia is, nevertheless, so uniform, that this widely-extended region, as regards the geographical distribution of its animals, forms but one natural kingdom, to which North America may be joined as a distinct province with its own differentiated types. That the Camelidæ, otherwise indigenous to North America, also spring to the surface in the East Indies, whilst they are absent in Europe, is a remarkable fact, for, as regards the rest, Europe and North America show closer connections with each other than North America and East Asia. For a number of genera such as *Elephas*, *Bison*, *Bos*, *Bubalus*, *Leptobos*, *Equus*, *Hippopotamus*, *Canis*, *Ursus*, *Semnopithecus*, and *Macacus*, which in Europe first make their

¹ The genera marked with (E) also occur in the European Miocene; those with (E*) in the European Pliocene.

appearance in the Pliocene, Southern India may be considered as the original home, even though the Sivalik beds may not contain in places, as Lydekker supposes, genuine Pliocene forms.

In strong contrast to the Miocene mammalian fauna spread over the entire Northern hemisphere, stand the probably contemporaneous forms of the so-called "Patagonia formation," in Patagonia and Uruguay. If one compares the following list of the genera known up to the present from these beds (from which the marine mammals, on account of their peculiar conditions of distribution, should be excluded) with those from North America, Asia, or Europe, it will be seen that their indigenous South American, or, according to Wallace's terminology, "Neotropical," character stands out not less prominently than in the older fauna of Santa Cruz.

MARSUPIALIA.	Dasypoda.	<i>Myopotamus.</i>
? <i>Notictis.</i>	<i>Proeuphractus.</i>	<i>Eucardiodon.</i>
<i>Apera.</i>	<i>Stenotatus.</i>	<i>Anchimys.</i>
<i>Cynonasua.</i>	<i>Chlamydotherium.</i>	<i>Procardiotherium.</i>
	? <i>Eulatus.</i>	<i>Cardiotherium.</i>
EDENTATA.		<i>Plexochaerus.</i>
Gravigrada.	PERISSODACTYLA.	<i>Caviodon.</i>
	Proterotheridæ.	<i>Lagostomus.</i>
<i>Promegatherium.</i>	<i>Proterotherium.</i>	<i>Megamys.</i>
<i>Interodon.</i>	<i>Brachytherium.</i>	<i>Tetrastylus.</i>
<i>Orthotherium.</i>		<i>Neoeptilema.</i>
<i>Pliomorphus.</i>	Macrauchenidæ.	<i>Euphilus.</i>
<i>Menilaus.</i>	<i>Scalabrinitherium.</i>	<i>Briaromys.</i>
? <i>Gnathopsis.</i>	<i>Mesorhinus.</i>	<i>Gyriabrus.</i>
<i>Promylodon.</i>	<i>Oxyodontotherium.</i>	<i>Calpostemma.</i>
<i>Pseudolestodon.</i>	<i>Macrauchenia.</i>	<i>Strophostephanus.</i>
<i>Lestodon.</i>		<i>Paradoxomys.</i>
<i>Diodonius.</i>	TOXODONTIA.	<i>Haplostropha.</i>
<i>Sphenotherus.</i>	<i>Toxodon.</i>	
<i>Ranculus.</i>	? <i>Eutomodus.</i>	CETACEA.
<i>Nephottherium.</i>	<i>Xotodon.</i>	<i>Pontistes.</i>
<i>Strabosodon.</i>	? <i>Stenotephanus.</i>	<i>Pontivaga.</i>
		<i>Pontoplanodes.</i>
Glyptodontia.	TYPOTHERIA.	<i>Ischyrorhynchus.</i>
<i>Hoplophorus.</i>	<i>Protypotherium.</i>	<i>Balæna.</i>
<i>Palæohoplophorus.</i>		<i>Notiocetus.</i>
<i>Proglyptodon.</i>	RODENTIA.	
<i>Neuryurus.</i>	<i>Discolomys.</i>	SIRENIA.
<i>Lomaphorus.</i>	<i>Morenia.</i>	<i>Ribodon.</i>
<i>Pseudoeuryurus.</i>	<i>Orthomys.</i>	

The Marsupials, Edentates, Toxodonts, Typotheridæ, as also the Perissodactyla and Rodents contained in the Patagonian (Miocene) mammalian fauna, are all of specifically South American types, elsewhere unknown. It is a more matured offspring of the Santa Cruz fauna, and is only distinguished from it by a stronger differentiation of particular genera. There is no trace of any intermixture of foreign elements which would indicate a connection with North America or with the fauna of the Northern world.

(To be concluded in our next Number.)

ERRATUM.—Page 409, column 1, in last number, for *Artiodactyli* read *Artiodactyla*.