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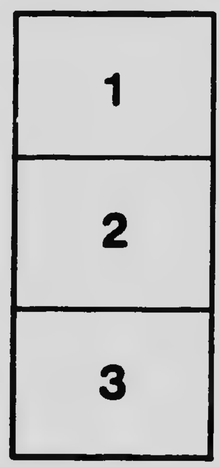

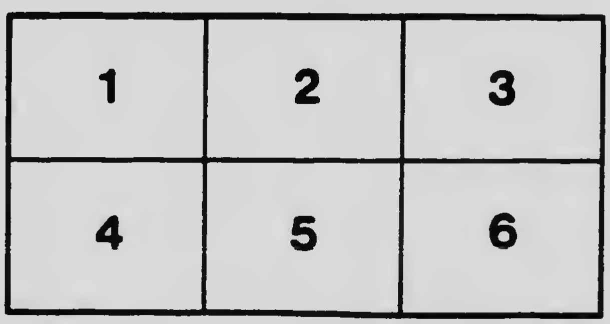

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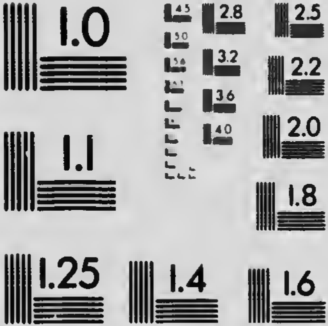

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BIONOMICAL LEAFLETS

Series XI - Zoology

No. 4. Fossil Fats
by
R. F. RUTTAN.

No. 5. Dorso-epitrochlear Muscle
by
F. SLATER JACKSON.

No. 6. West Coast Corals
by
SYDNEY J. HICKSON

No. 7. Introduction to Zoology
by
A. WILLEY.

MONTREAL, 1917.

IV. *Fossil Fats.*—The term fossil fat is rather an apt one to designate certain modifications of animal or vegetable fats produced by long exposure to moisture in the absence of air. Natural fats are known to acquire new properties under these conditions, becoming harder, and more resistent to the action of air, enzymes and bacteria. They lose their characteristics as fats and assume those of organic minerals.

Authorities on mineralogy recognize as minerals: (1) Substances of the type of ozocerite, a brown, hard, amorphous wax, which is simply a solid paraffin produced by terrestrial forces in a similar way to crude petroleum, and, like petroleum, is composed of carbon and hydrogen only. (2) Substances of a bituminous character such as amber, etc., and acids allied to it of which succinellite is an example; these contain oxygen as well as carbon and hydrogen and are, either wholly or in part, organic crystalline acids which may be separated by distillation or as salts of lead, barium, etc. (3) A fat-like mineral of the consistence of butter called *Brücknellerite*, found associated with certain deposits of brown coal. It gives rise to an acid and contains C, H, and O. **Organic minerals**

It is not surprising, therefore, that the material popularly called "Bog Butter," which occurs occasionally as masses of hard fat in the bogs of Ireland and Scotland, was confused with minerals of the type referred to above and learnedly described by mineralogists as Butyrite or Butyrellite. Dana's *Mineralogy* defines this mineral: "crystallizable in needles; butter-like in consistence; color white; melting point of impure native material 47° Brazier, after purification 51° Luck, 52°-52.7° Brazier; easily soluble in alcohol or ether; consists of C, H, and O."

It was described as "a mineral resin, a perfectly natural production arising from the decomposition of vegetable matters growing in peat and bog." No recent analyses of this material have been made, but between 1880 and 1890 it was identified as "just butter" by a number of chemists who found specimens to contain milk sugar and cows' hairs, oleic, palmitic and stearic acids. Remarkably fine specimens of bog butter have been preserved in Edinburgh in the Antiquarian Museum and in the Museum of Science and Art. Numerous specimens are also to be seen in the Museum of the Royal Irish Academy, Dublin, and in the Belfast Museum. The Duke of Sutherland is said to possess a large collection of Butyrellite specimens. When found they often show markings of the cloths, rushes, etc., in which they were wrapped, or the remains of boxes and other containers. One specimen was found in a hollow log. This bog butter was supposed by the superstitious Irish peasants to have been made and hidden by the numerous fairies that frequent the bogs. We find, however, many references in the folklore of Ireland to the "butter dyke" or butter safe being dug in the bogs where the butter was stored to keep it sweet and cool in summer. (Sir William Wilde: *Introduction . . of the potato in Ireland . . with some notice of the substance called bog-butter.* Proc. Roy. Irish Acad. VI, 1857, p. 356.) **Bog butter** **Fairy butter**

Numerous analyses and microscopic examinations, while establishing its origin, failed for the most part in interpreting the changes which the butter had undergone while buried in the wet bog. Ultimate organic analyses of the acids obtained led to the conclusion that the acid was of the same composition as palmitic acid. Wigner and Church (Analyst, Feb. 1880, p. 17) examined a specimen "several centuries old" and found it to possess properties similar to those described by numerous other chemists. The melting point varied from 47° to 54° C. [butter melts at 31–33° C.]. The acids found were chiefly palmitic and stearic, with about 5–10 per cent. oleic; while only minute traces of glycerol were discovered, the fact that the mass was practically composed of fat acids was overlooked.

Analysis of buried butter

Salkowski's analysis

E. Salkowski (Festschrift f. Virchow, 1891) analysed a sample of butter which had been left exposed to the air for three years, and found that 87 per cent. of the fat had become hydrolysed to fat acids and only traces of glycerol could be found; its melting point had risen to 49° C. showing the absence of the volatile acids of low molecular weight.

Hydrolysis of butter

The conversion of butter into Butyrellite is a slow process of hydrolysis, where the fat, in the presence of large excess of reacting water, is gradually broken down into the fat acids and glycerol. The fat and water are in equilibrium with glycerol and fat acids; the glycerol is soluble in water as well as the lower fat acids, both are therefore dissolved out and the reaction proceeds from left to right until after many years only the insoluble fat acids, palmitic and stearic, remain. Nearly all the oleic acid is also removed mechanically in suspension. These solid, hard fat acids are very stable, not easily oxidized and do not undergo putrefactive change. Hence the change from butter fat to Butyrellite or bog butter is a conversion of the original mixture of fats practically to a more solid mixture of palmitic and stearic acids melting at about 50° C.

Funerary butter

An analysis of butter 2,500 years old, found sealed up in an alabaster vase taken from the tomb of Queen Hasheps of the 18th Egyptian dynasty, is recorded. It had a low melting point, carried 8 per cent. of volatile soluble acids, gave the reaction for glycerine, and "in appearance, colour and odour resembled rancid butter" (Wigner and Church, Analyst, Feb. 1880). The butter was probably fused into the vase and remained out of contact with air 25 centuries. In the absence of water and air there were none of the changes observed in bog butter; the fats were only partly hydrolysed.

The apparent conversion of the bodies of animals into a hard white wax after long burial in wet ground was an interesting but until quite recently an unexplained phenomenon. It was regarded as evidence of the conversion of protein tissue into fat, but in the light of recent investigations this view is no longer tenable. The name Adipocere was given to this waxy substance by Fourcroy* in 1787 when he made a study of the bodies of a

Adipocere

* A. F. de Fourcroy (1755-1809): Mémoires sur les différents états des cadavres trouvés 1786 et 1787, lus à l'Academie des Sciences, Paris, 1789.

number of infants which had been partly converted into this waxy material. These bodies were being removed from the Cimetière des Innocents in Paris. He concluded that the wax was similar to cholesterol and spermaceti mixed with soaps and phosphate of lime. Since that time this substance, under the names of *Leichenwachs*, *Cera cadaverica*, and adipocere, has been frequently but very incompletely analysed. The general result of these analyses up to 1916 was to show that this material was composed chiefly of palmitic, stearic and margaric acids, with ammonia and lime soaps, and an acid melting at 79–80° C. which was called stearic acid by Gregory, hydroxymargaric by Ebert. The absence of glycerol was first observed by W. Gregory in 1847, thus showing that the material was not a true fat.

The view that adipocere results from the conversion of the various components of the tissues into fat was a very natural one. The form of the body is often retained and even the features are sometimes so well preserved in very fat bodies as to be almost recognizable, as shown in some recent photographs by W. Müller (Archiv. f. Hygiene 1916, p. 285) of a number of corpses of fat persons buried for over 20 years. Several observers, Ipsen, Kratter, Zillner, and others have, when studying the microscopic structure of portions of adipocere, observed cells of adipocere similar in shape and sometimes in markings to spindle-shaped striated muscle cells. This is undoubtedly due to the infiltration of the sheath of the muscle by the fats and their subsequent change *in situ*, in other words they are pseudomorphs. **Pseudo-morphs**

The impression that the entire body is converted into adipocere is due to the fact that the fat of the *panniculus adiposus* (subcutaneous fat) is early hydrolysed and hardened, the skeleton remains to hold the soft parts in position, and there is a gradual infiltration of the muscular tissue which entirely disappears as well as the glandular organs which are not converted *in situ*: irregular masses of adipocere are, however, found in the interior of these cadavers. On examination, the cadaver is found to be but a shell inclosing parts of the skeleton, the whole often weighing not more than 20–30 lbs., and usually an air space separates the bones from the adipocere shell. In old specimens the bones also have almost disappeared, while the adipocere shell may resist dissolution indefinitely. **Adipocere shell**

Adipocere occurs almost exclusively in the bodies of fat animals and is the product of the saponification and hydrolysis of the pre-existing fat of the cadaver. Furthermore, this change only occurs in bodies of animals buried in wet ground or submerged in mud and water. The changes which result in the formation of mature adipocere from fats are as follows: (1) The slow hydrolysis of the fats at low temperatures where the time factor and the mass of the reacting water are enormously exaggerated. [Rapid hydrolysis of fat by steam is accomplished in a few minutes and is one of the steps in the commercial process of soap-making.] (2) The constant removal of the resulting glycerol as soon as it is liberated from the fat. (3) The mechanical removal of a large portion of the fluid oleic acid, in form of an emulsion. (4) The **Summary of changes** fixation of a portion of the fat acids as insoluble calcium and magnesium soaps. (5) The conversion of a portion of the oleic acid into hydroxystearic acids by taking up a molecule of water for each molecule of the oleic acid. There are two isomeric hydroxystearic acids. These are hard waxy crystalline bodies probably characteristic of all adipocere, whether human or otherwise, and are present in largest proportion in mature waxy specimens. (R. F. Ruttan and M. J. Marshall, Journ. Biol. Chemistry, XXIX, 1917, p. 319; also Ruttan, Trans. Roy. Soc. Canada, Abstracts, 1917).

New adipocere acids

Four analyses of adipocere have been made by the writer, including both the mature waxy and the immature soft forms; three of these were of human origin and one was the back of a pig which had been buried for 45–47 years near Montreal. They all contain less than 2 per cent. of true fats. They all contain the same mono-hydroxystearic acids found in pig's adipocere, one prismatic iota-hydroxystearic acid melting at 84.5°C. and the other theta-hydroxystearic acid in rhombic plates melting at 78.4°C. The soft adipocere differs from the waxy form only by containing more oleic acid and soft remnants of connective tissue. The hydration of oleic acid to the hard hydroxystearic acids and the disappearance of unaltered oleic acid mark the final stages in the formation of mature adipocere.

Pig adipocere

Complete hydrolysis of fat, under the conditions favourable for adipocere formation, occurs even in the presence of soft proteins [one analysis gave 8.9 per cent. protein as muscle fibre and connective tissue] and in the bone marrow which was found to be converted into calcium soaps and fat acids with traces only of glycerides. In no case could ammonia soaps be detected. The nitrogenous matter was present chiefly as fibrous tissue; only 0.03 to 0.05 per cent. of ammonia was detected. Adipocere contains no margaric or hydroxymargaric acids as stated in textbooks; the eutectic mixture of palmitic and stearic acid was mistaken for the former, and the latter was a name applied by Ebert to the mixed hydroxystearic acids.

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V. *Dorso-epitrochlear muscle.*—The following notes are based upon a dissection of a Virginian Opossum (*Didelphys virginiana*) and embody a brief description of the muscle in this species, together with a résumé of the more important literature relative to its occurrence in other forms. My attention was first drawn to it some years ago by Dr. Francis J. Shepherd, then professor of anatomy at McGill University, with reference to its occurrence as an occasional anomaly in the human subject. In 1906 when on an expedition to West Africa I had the opportunity of noting its appearance in various monkeys. In 1912, being in Pensacola, Fla., on my way from Pará to New York, I dissected an opossum purchased at the market. The semi-diagrammatic sketch of the dissection, made on ship-board, is herewith reproduced, since the *M. dorso-epitrochlearis* of Marsupials is frequently referred to, but rarely figured.

The dorso-epitrochlear muscle belongs topographically to the group of muscles whose function is the extension of the forearm. It is an accessory bundle of fibres passing from the region of the arm-pit to the elbow in many mammals. In anatomical usage it is frequently not described along with the intrinsic muscles of the anterior limb, but with the muscles of the trunk. This is because of its peculiar method of origin as a slip or offset from the *latissimus dorsi*, a broad sheet of muscle which flanks the body of terrestrial vertebrates and is an extrinsic muscle of the fore limb, passing from the dorsal vertebræ and lumbar fascia to the proximal part of the shaft of the humerus.

Owen on Marsupials

In the article "Marsupialia" in Todd's Cyclopædia of Anatomy and Physiology (vol. III, London, 1847), Sir Richard Owen referred to the *latissimus dorsi* of Marsupials in these words: "The chief peculiarity of this muscle is its connection with an accessory extensor (*omo-anconeus*) of the antibrachium. This extensor takes its principal origin by fleshy fibres from the terminal half-inch of the fleshy part of the *latissimus dorsi*, and continues fleshy, slightly diminishing in size to its insertion at the apex of the olecranon; it may thus be considered as a slip detached from the *latissimus dorsi*."

Didelphys

As will be seen by the figure, the *dorso-epitrochlearis* in the opossum is a definite muscular band of parallel fibres arising from the *latissimus dorsi* near its humeral insertion, and proceeding to the olecranon process, whence Owen's term *omo-anconeus*. It is fleshy throughout, except at its insertion, its flattened tendon blending with the adjacent fascia.

Duvernoy on the Gorilla

A corresponding muscle was described in the Gorilla by G. L. Duvernoy in 1855 [Archives du Muséum, Paris, VIII, 1855-56] under the name " dorso-épitrochlien "; and on p. 11 of the third volume of the *Anatomy of Vertebrates* (1868) there is a footnote in which Owen seems to suggest a claim of priority for the name *omo-anconeus*, which he gave to the muscle in 1846-47. However that may be, the name employed by French anatomists has been currently adopted with few exceptions by English writers. One of the exceptions was C. W. Devis [*Notes on the Myology of Viverra civetta*, Journ. of Anat. and Physiol. II, 1868, p. 211] whose account follows: " *Latissimus dorsi*, originating as usual, is inserted by a broad tendinous band into the ridge below the fore and inner part of the head of the humerus beneath the biceps. The lower edge of the tendon is much the stronger, and is folded upon itself. To the upper edge the *teres major* has a fleshy attachment; to the tendinous margin below, the *omo-anconeus* is attached just before the commencement of the tendon proper. The *omo-anconeus*, rising as above, is not inserted into the olecranon, but is attached to the aponeurosis round the inner edge of the elbow, and finally merges into that of the inner muscles of the fore-arm."

African Civet Cat

Terrestrial Carnivora

In their paper *On the Myology of the Terrestrial Carnivora* [Part I, Proc. Zool. Soc., London, 1897, pp. 370-409] Sir Bertram Windle and Dr. F. G. Parsons say, with reference to the *dorso-epitrochlearis* (p. 386): " This muscle shows frequent variations in its size and attachments; its usual origin, as in most other animals, is from the *latissimus dorsi* just before the latter becomes tendinous; it then runs down the inner side of the triceps to be inserted into the inner side of the olecranon process as well as into the fascia of the forearm. It is supplied by the musculo-spiral nerve." Their fig. 8, p. 390, shows its insertion in the case of the dog. For the cat, the muscle is described and figured, under the name *M. epitrochlearis* or *extensor antibrachii longus*, by J. Reighard and H. S. Jennings in their textbook: *Anatomy of the Cat* [New York, Henry Holt, 1901, p. 164]; in the cat it is a thin flat muscle on the medial side of the brachium.

Windle and Parsons: *On the Myology of the Edentata* [Part I, Proc. Zool. Soc., London, 1899, pp. 314-339] describe this muscle (p. 323) under a new name, *latissimo-olecranalis*. It is always present in Edentates: " In the Dasypodidæ [armadillos] the muscle is very large and often has further origins than that which it obtains from the *latissimus dorsi*. In *Dasypus* we found it rising (*a*) from the main insertion of the *latissimus dorsi*, (*b*) from the dorsum scapulæ, and (*c*) from that part of the *latissimus dorsi* muscle which arises from the thoracic vertebræ. The muscle covered the dorsal and internal aspects of the arm and was folded round the triceps in such a way as to render that muscle invisible until the *latissimo-olecranalis* was removed. The insertion was into the olecranon and upper half of the subcutaneous margin of the ulna. This is the maximum development of the muscle so far met with by us in any mammal."

Armadillos

As regards the special anatomy of the order Rodentia, a standard work was that of St. George Mivart and James Murie: *On the Anatomy of the Crested Agouti* (*Dasyprocta cristata Desm.*) [P. Zool. Soc., London, 1866, pp. 383–417], where the muscle in question is described and figured. The *latissimus dorsi* of the agouti arises from the dorsal and lumbar vertebræ, and is attached by a fascia to the surface of the *infraspinatus* muscle. It has an insertion by tendon, as usual, in common with the *teres major:* " It sends off a small dorso-epitrochlear slip to the ulnar side of the olecranon. This last we noticed in the Guinea-pig, but not clearly in the specimens of Rabbit and Hare." It is visible at the posterior border of the upper arm of the agouti when viewed both from the inner aspect of the forelimb (*l.c.* fig. 2, p. 396) and from the outer aspect (*l.c.* fig. 3, p. 401). Above is the only reference to the apparent absence of the dorso-epitrochlear muscle in the Rabbit which the writer has met with. There does exist in the Rabbit, however, a muscle which, in default of other homologies, may perhaps represent it, namely, the *extensor antibrachii parvus* (=*anconeus quintus* W. Gruber, 1870). This flat muscle arises from the fascia of the united *teres major* and *latissimus dorsi* or simply from the subcutaneous fascia on the medial side of the upper arm; it runs down on the medial side of the *anconeus longus* or scapular head of the triceps to its insertion into the medial hinder margin of the olecranon, and is not to be seen from the outer aspect of the limb; it is supplied by the musculo-spiral or radial nerve (W. Krause).

Agouti · **Rabbit**

F. G. Parsons: *On the myology of the Sciuromorphine and Hystricomorphine Rodents* [P. Zool. Soc., London, 1894, pp. 251–296] says (p. 276): " The *dorso-epitrochlearis* is always present, occasionally blending with the fascia over the *triceps*, but more often being well marked and inserted into the olecranon process. The *dorso-epitrochlearis* is, perhaps, least well seen in *Lagostomus* and *Dasyprocta*, best in *Sphingurus*." The same author, in continuation of his investigations on the myology of Rodents [Part II, *Myology of the Myomorpha*, P. Zool. Soc., 1896, pp. 159–192] finds (p. 175) that in this division " the *dorso-epitrochlearis* is always present and reaches as far as the olecranon, though in *Cricetomys* it is also inserted into the fascia of the forearm."

Rodentia

Testut (1884, see below) states that in a great many animals, notably in apes, the great dorsal muscle, before reaching the humerus, gives off a muscular band to the inner side of the elbow. It descends vertically along the *triceps brachii* to its insertion at the humero-cubital joint. According to the species and even individuals, it is attached either to the epitrochlea (inner condyle) of the humerus, or to the olecranon, or to both of these points. It was given a new name, *latissimo-condyloideus*, by Th. Bischoff, in 1870. Testut adds further that the muscle had been observed by J. F. Meckel (1822) in the South American hairy anteater (*Myrmecophaga*), in the Sloth (*Bradypus*), and in the Virginian Opossum (*Didelphys*). In the Hyæna, Meckel found a strong fleshy band proceeding from the great dorsal muscle to re-inforce the long head of the triceps. In the Seal (*Phoca*) it descends much lower, being attached to the antibrachial aponeurosis as far down as the palmar

Testut's observations · **Seal**

fascia, functioning as a retractor of the entire fore-limb. Testut also describes its relations and dimensions in a wolf and a bear. In the African monkeys called guénons (*Cercopithecus*), he found the muscle very broad, enveloping the cylindrical body of the triceps.

Orang In the Orang the relations of the muscle have been discussed by Dr. A. Primrose: *The Anatomy of the Orang Outang (Simia satyrus)* [Trans. Canadian Inst. VI, Toronto, 1899, pp. 507-598, plates III–VI and bibliography]. Quite recently the dorso-epitrochlear muscle has described for Lemurs, Tarsius, Cercopithecidæ, and Gorilla, by Dr. W. L. H. Duckworth [*Morphology and Anthropology*, 2nd edit. vol. I, Cambridge Univ. Press, 1915]; the passage relating **Gorilla** to the Gorilla (p.182) may be quoted: "The M. dorsi-epitrochlearis needs no special description, but its retention would appear to be determined by that of the use of the limb for climbing."

The dorso-epitrochlear muscle is a constant organ in lemurs, monkeys, and anthropoid apes, but is normally absent in the human **Wood on human myology** subject, where its occasional appearance was first demonstrated by Mr. John Wood in a remarkable series of papers on *Variations in Human Myology*, published in the Proceedings of the Royal Society of London between the years 1864 and 1870. In 1867 (Proc. Roy. Soc. XV, p. 524) he records finding in two subjects, that "the tendon of the *latissimus* gave attachment to a strong, thick muscular slip, which, passing separately down the upper fourth of the arm, finally joined to long head of the triceps, presenting the most marked approximation to the dorso-epitrochlear muscle in the Orang and other Simiadæ which the author has hitherto found in the human subject." On account of the importance of this discovery, which has been several times confirmed, a special article was devoted to the muscle by L. Testut in his volume entitled: *Les anomalies musculaires chez l'homme expliquées par l'anatomie comparée: leur importance en Anthropologie*, Paris (G. Masson), 1884, pp. 118-125.

Textbooks of human anatomy (*e.g.*, Quain, Gray) recognize a vestige of the *dorso-epitrochlearis brachii* or *accessorius tricipitis* in the fibrous band passing from the tendon of the latissimus to the fascia of the arm. It is described by Professor Arthur Keith (*Human Embryology and Morphology*, 3rd edit. London, Edward Arnold, 1913, p. 438) as follows: "The *latissimo-* **Climbing muscle** *condyloideus* (dorsal epitrochlearis), a climbing muscle, is always represented in man, commonly by a fibrous bundle between the tendon of the latissimus dorsi and the long head of the triceps (Fig. 422). It may be occasionally muscular. In apes it passes from the latissimus dorsi at the axilla to the inner aspect of the elbow and arm, which it retracts in climbing. It belongs to the same sheet as the coraco-brachialis. The *ligament of Struthers* [internal brachial ligament]—a strip of fibrous tissue over the internal intermuscular septum, above the internal condyle—represents part of the tendon of this muscle."

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VI. *West Coast Corals.*—The list of species of stony and flexible corals given in this paper represents, probably, only a fraction of those that live in the waters of the Pacific coast from Puget Sound to Alaska, and my object in publishing it now is to call attention to our want of knowledge of these beautiful forms of marine life and to the interesting problems of distribution which further information may help to solve. There has been no attempt to collect and send to the systematist a complete set of specimens from any part of the coast, and I am inclined to think that some of the very common species have not yet been recorded. The type of coast line extending from Puget Sound to Behring Strait, with its deep-water fjords, its archipelago of islands and rocky prominences, is just the type of coast off which we might expect to obtain quite a rich fauna of these sedentary forms of animal life: not so rich, perhaps, as we find off a similar coast in the warmer tropical waters, but rich as compared with the silt-laden waters of the coasts at corresponding latitudes in the northern hemisphere.

Order Pennatulacea: the Sea-pens.

Sea-pens

1. *Osteocella septentrionalis* Gray (1872). This is a long fleshy sea-pen attaining to a length of 8½ feet and an average diameter of about two inches. The rachis, occupying two-thirds of the length of the body, is provided with numerous transverse rows of polyps, and the remaining third (the stalk) is smooth, ending with a large bulbous swelling. It is sometimes caught on the halibut hooks in about 30 fathoms; when alive it is of a pale pink colour and is said to writhe like a worm. Running down the middle of the fleshy body is a smooth skeletal rod of bone-like hardness, known as the axis, whence the name Osteocella given to it by Gray in 1872. The best description of the species was first given by Moss (1873), who showed that Gray's *Osteocella* is the axis of a Virgularian actinozoon. **Osteocella**

TABLE OF SYNONYMS:

1872. Osteocella septentrionalis Gray. Ann. Nat. Hist. (4), IX, 405.
1873. Osteocella septentrionalis Moss. P. Zool. Soc. Lond. 730 (from Burrard's inlet, Frazer River).
1873. Verrillia blakei Stearns. P. Calif. Ac. V, 148 (Barracuda inlet).
1882. Halipteris blakei Stearns. Amer. Nat. XVI, 55.
1909. Balticina finmarchica Nutting. P. U. S. Nat. Mus. XXXV, 704.
1911. Osteocella septentrionalis Hickson. Manchester Mem. 55, No. 23 (off Lucy island, S.W. of Metlakatla).
1913. Pavonaria willemoesi Kükenthal. Zool. Jahrb. Syst. XXXV, 252.

Osteocella is most closely related to *Pavonaria*, of which the type species was found off the coast of Finland and in other locali- **Pavonaria** ties of the north Atlantic. It differs from *P. finmarchica* in the absence of spicules in the polyps, in the presence of ventral radial canals, and in other characters; but as other species attributed to the genus Pavonaria (*californica* and *willemoesi*) have been described from the Californian coast, it would be important to determine if the American species of Pavonaria are intermediate between *Osteocella septentrionalis* and *P. finmarchica*.

Sea-pen from Hecate strait

2. *Leioptilum quadrangulare Moroff.* This is an orange-red sea-pen, about four inches long, living in abundance on the halibut grounds in Hecate strait, in 28-50 fathoms. It differs from Osteocella in its small size and in having the rows of polyps fused to form kidney-shaped leaves with thickened, sinuous and fimbriated margins. The leaves, about 30 on each side of the rachis, are closely pressed together like the barbs on the rachis of a feather. If the margin of one of these leaves be examined under a lens, two or three rows of small tubercles will be seen, each tubercle provided with two short tooth-like processes. These tubercles are the calices of the polyps and the marginal teeth are characteristic of the species.

Sea-pen in stomach of haddock

Professor Milnes Marshall, in 1882, recorded, on the authority of Mr. R. D. Darbishire, that pieces of the British sea-pen, *Virgularia mirabilis*, were found in the stomach of a haddock caught off Scarborough; but this is the only instance I have found of any sea-pen that is a prey of fishes.

The genus *Leioptilum* (with which *Ptilosarcus* is now incorporated) seems to be confined to the west coast of America, the single record of a specimen from New Guinea being of doubtful accuracy. Several species have been described, but owing to their specific variability it may prove that there is but one species of the genus. The two specimens from Hecate strait that were sent to me for examination agree closely with the full description of *Ptilosarcus quadrangularis* recently given by Nutting. He examined a number of specimens from Pacific Grove, California, some of them attaining to a length of 22 inches, varying in colour from purplish violet to yellow.

1902. Ptilosarcus quadrangularis Moroff. Zool. Jahrb. Syst. XVII, 363.
1909. Ptilosarcus quadrangularis Nutting. P. U. S. Nat. Mus. XXXV, 689.
1913. Leioptilum quadrangulare Kükenthal. Zool. Jahrb. Syst. XXXV, 252.

Sea-fans

Order Gorgonacea: the Sea-fans.

3. *Paragorgia arborea* (Linn). Of the attached forms of Alcyonarian corals only five species are known from British Columbian waters. The most conspicuous of these is a large ramified coral of brick-red colour and friable consistency, with terminal branches about half an inch in diameter, characterised by many node-like swellings. When dried, the branches and the main stem are seen to be perforated by many fine longitudinal canals, and the substance of which they are composed can be crushed

into a powder between a strong finger and thumb. It would not be surprising to hear of specimens several feet in height. The largest I have seen was given to the Manchester museum by Dr. C. Gordon Hewitt, and is 16 by 12 inches in expanse, but it is certain that this specimen is only part of a much larger colony. The generic name of this coral is *Paragorgia* H. Milne-Edwards 1857, of the family Briareidæ. Having made a careful comparison of a specimen from off Kodiak island, Gulf of Alaska, with one of *P. arborea* (Linn.) from the coast of Norway, I have no hesitation in referring the Alaskan form to the Norwegian type (Hickson, P. Zool. Soc. 1915, p. 548).

Friable coral

4. *Primnoa willeyi* Hickson (1915, *op. cit.* p. 551). There are two species of flexible corals of the family Primnoidæ, characterised by the presence of non-retractile polyps protected by an armature of overlapping scales. In one of them (*P. willeyi*) the colony branches profusely and irregularly. The polyps are about five mm. in length, irregularly distributed on the branches, and they bend downwards towards the base of the colony. There are only two other species of this genus, namely, *P. reseda* Pallas, from the north Atlantic, and *P. pacifica* Kinoshita, from the coast of Japan. This genus therefore, like Paragorgia, is circumpolar. The dried corallum of *P. willeyi* has been seen exposed for sale in a shop window at Prince Rupert, but the only one known officially was obtained in 100 fathoms off Moresby island: the colony, of which only fragments were preserved, having when fresh a scarlet colour, an expanse of four feet, and diameter at the base of the stem of 1½ inch.

Primnoidae

Circumpolar distribution

5. *Caligorgia fraseri* Hickson. In this Primnoid the branches are in one plane and not so profuse. The polyps are about one mm. in length and are arranged in closely set whorls of 11 or 12, diminishing to five or six near the ends; all the polyps are bent upwards towards the apex of the branch. It is frequently brought up by the halibut lines from 50 to 100 fathoms in the gulf of Alaska; it has a pink colour when fresh. The genus *Caligorgia* has a wide distribution in tropical seas; in the Pacific ocean it extends as far north as the Aleutian islands, but according to Versluys (*Primnoidæ of the Siboga Expedition*, 1906), it has not been found in the north Atlantic. It may be regarded as a migrant from the south, whilst *Primnoa* is a migrant from the north.

Polyps in whorls

6. *Psammogorgia teres* Verrill (Hickson, 1915, *op. cit.* p. 554). This is another flexible coral, of the family Plex[illegible]idæ, candelabrum-shaped, having a persistent pink colour [illegible] branches sparsely in one plane and the horny axis is covere[illegible]th a thick crust of living substance. The polyps can be completely retracted into the crust and in dried specimens are represented by little pits or warts. The only specimen I have seen is 4½ inches in height, and the branches about one-fifth inch in diameter.

Plexauridae

Order Stolonifera: social alcyonarians.

7. *Clavularia moresbii* Hickson (1915, *op. cit.* p. 546). This species is founded upon a colony of polyps ¼ to ½ inch in length, arising from a creeping stolon which spread over the base of the stem of *Primnoa willeyi*. It will probably be found upon other

Clavularia

objects as it is not likely that there is any special association between the two species.

Stylaster norvegicus

Order Stylasterina: hydrocorallines.

8. *Stylaster norvegicus* Gunnerus. Of the more solid stony corals, only three species have been recorded from the region under question. The first of these is the Hydroid coral, *Stylaster norvegicus*. This may be distinguished by its permanent salmon-pink colour (which might vary to white) and by the little cycles of six or seven pores, frequently called the calices, distributed irregularly all over the surface of the branches. The calices are less than 1-25th inch in diameter. It has been taken by Professor McMurrich from the Swiftsure Shoal, off Barkley Sound, west of Vancouver island.

1768. Millepora norvegica Gunnerus, Norway.
1868. Allopora californica Verrill, California.
1869. Allopora venusta Verrill, Queen Charlotte islands.
1885. Allopora verrillii Dall, Aleutian islands.
1885. Allopora moseleyi Dall, Aleutian islands.
1885. Allopora papillosa Dall, Aleutian islands.
1914. Stylaster norvegicus Broch, Norway.
1915. Stylaster norvegicus Hickson, Swiftsure Shoal.

Solitary corals

Order Madreporaria: true stony corals.

9 and 10. Of the true white madreporarian stony corals, only two species have been described from the west coast by Verrill (1869, Trans. Conn. Acad. I), namely, *Balanophyllia elegans* from Puget Sound, and *Paracyathus caltha* from California. The former species was also found at low water at Monterey, California, under stones, the polyp being coloured orange-red when alive. They are both solitary corals consisting of a single calyx with a large number of radial septa. They have been recorded from 20 fathoms off the Queen Charlotte islands (Whiteaves, Geol. Survey, Canada, for 1878-9).

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VII. *Introduction to Zoology.*—Daily manifestations of mammalian life are brought to our notice. Besides civilized man, we find domesticated horses, cats and dogs, cattle, sheep and pigs, and nocturnal rats, mice and bats, fulfilling their inherited destinies. All these beings agree in having the skin clothed in varying degree with hair, in shedding milk teeth before the permanent set becomes established, in suckling their young and in having a period of **Mammals** gestation or intra-uterine development. During this period the egg or female germ-cell, which is of very small size, after having been fertilized by a male germ-cell or spermatozoon, is retained within the uterus instead of being laid, and the developing organism is nourished at first by means of an embryonic organ, the blastocyst, and later by means of a fœtal organ, the placenta. The fœtus is protected by a veil-like membrane, the amnion, derived from the wall of the blastocyst, which encloses a space, the amniotic cavity, filled with an amniotic fluid in which the fœtus is immersed.

Birds have the fore-limbs transformed into wings, the skin clothed with **Birds** feathers, and the jaws covered by a horny beak in place of the lost teeth; after fertilization the egg, which is of large size on account of the quantity of food-yolk, is encased by a calcareous shell and is then laid. The developing organism is nourished by the yolk and by the surrounding albumen, and is protected within the shell by an amnion.

Reptiles have the body covered with epidermal scales which are **Reptiles** periodically shed (snakes, lizards), or with horny shields which are not shed (alligators, tortoises); the teeth (absent in tortoises) are continually renewed; the egg is of large size and is generally, though not in all cases, laid in the ground; the embryo is furnished with an amnion.

Batrachians (frogs, toads, salamanders) have a naked skin, small **Batrachians** conical teeth (absent in toads), and the egg is generally fertilized while being spawned into water. The procreation of frogs, said the Rev. Gilbert White in *The Natural History of Selborne* (1789), is notorious to everybody, for "we see them sticking upon each other's backs for a month together in the spring." There is no amnion, and the embryo develops into a gill-breathing larva or tadpole which swims by its muscular tail and feeds upon vegetable matter; as the [illegible] grows it acquires lungs and limbs and gradually becomes metamorphosed into the shape of the adult. Because of this double life, aquatic and terrestrial, they are often called Amphibia.

Mammals and birds are warm-blooded, maintaining a constant normal **Tetrapoda** temperature; reptiles and batrachians are cold-blooded, the temperature varying with that of the surrounding medium. These are the four classes of Tetrapoda.

Fishes have gills, fins, dermal scales below the epidermis, and conical **Fishes** teeth. The eggs are provided with a varying quantity of yolk, and are commonly discharged into the water, though not a few fishes are viviparous.

The five classes mentioned above are Vertebrata, possessing **Vertebrata** an internal skeleton which includes the backbone (spinal or vertebral column). Animals whose hard parts are at the surface of the body, as the shells of molluscs and carapace of crabs, and those which have no hard parts, as the worms, are said to be invertebrate. The largest molluscs (squids, cuttlefish, octopus) have no shell visible on the outside, and the octopus has no hidden **Molluscs** shell; in a sense, these large carnivorous creatures may be said to have grown out of their shell. Their manner of growth and plan of composition show them to be the most highly differentiated Mollusca. The least differentiated of the shell-bearing Mollusca belong to the marine family Chitonidæ; instead of having a single spiral shell like the snail and the whelk, or a bivalve shell like oyster and clam, they have a series of eight small shelly shields placed in a row, one behind the other, along the back. There is a very full exhibition of these in the Carpenter collection of shells in the Redpath Museum.

Invertebrate animals

Other invertebrate animals of common life are lobsters, crabs, shrimps and prawns, all of which are marine crustacea. Closely related to the lobster is the freshwater crayfish, this name being an anglicized corruption of the French word *écrevisse*. House-flies and mosquitoes, butterflies and moths, ants, bees and wasps, cockroaches and potato beetles are insects. Spiders and scorpions are arachnids, this name being derived from Arachne, the inventress of the art of weaving, who was wisely changed into a spider by Minerva. Scorpions do not spin webs, but are otherwise related to spiders and are therefore placed in the same class.

Arthropoda

Crustacea, insects and arachnids agree in having a hardened cuticle forming an exoskeleton, in contrast with the bony and cartilaginous endoskeleton of vertebrates. The cuticle is composed of an organic substance called chitin, which is highly resistant to chemical action and has something of the consistency of horn; it may be freely defined as a carbohydrate substance allied to vegetable cellulose, with the addition of a nitrogenous radicle. Besides their chitinous exoskeleton, these animals have a segmented body and jointed appendages, some of which are used for locomotion, others as mouth-parts and sense organs. On this account they are all classified together in the phylum Arthropoda. In the segmentation of the body and in the general character of the nervous system, they agree also with the annelid worms (earthworms, nereids), and for this reason Cuvier created a more comprehensive subdivision of the animal kingdom which he called Articulata.

Radiata

Cuvier (*Règne Animal*, 1816) recognized four main subkingdoms: Radiata, Articulata, Mollusca and Vertebrata. The last three were well founded, but the Radiata proved to be a heterogeneous assemblage, bringing together such diverse forms as coral polyps and starfishes. These present a superficial resemblance in so far that, instead of the usual bilateral symmetry of animals, they exhibit a radial symmetry like that of flowers. But there is a deep-seated difference between them: coral polyps and their relatives, the hydroid polyps and medusæ, have a single continuous body-cavity, the gastrovascular cavity or cœlenteron; starfishes and their relatives the sea-urchins, sea-cucumbers and sea-lilies, have an alimentary canal surrounded by a secondary or peritoneal body-cavity as in the higher forms, and a water-vascular system in addition. Consequently, Cuvier's division, Radiata, has been superseded and its members distributed between the phyla Enterocœla (cœlenterates) and Echinoderma.

Histozoa

All the preceding forms of animal life develop normally from fertilized egg-cells and are composed of a multitude of cells of microscopic dimensions, each cell consisting of a centre of metabolic energy, called the nucleus, and its surrounding auxiliary protoplasm. All the tissues of the body (connective, muscular, epithelial), have their distinctive cell-elements. These multicellular animals have been named Metazoa ("secondary animals") or Histozoa ("tissue animals," Lankester), the former term being more commonly employed, though the latter is more expressive.

Micro-organisms

Another world of life, that of the micro-organisms, remains to be considered. These comprise microscopic green plants (algæ), unicellular animals (protozoa), and bacteria. Protozoa ("primary animals"), feed upon algæ, bacteria, other protozoa, and even upon rotifers ("wheel-animalcules"), which are minute Histozoa; some imbibe nourishment from nutrient media, such as putrefying substances, infusions, and the juices of higher animals. It is important to state that a typical protozoon is an individual organism equivalent to the whole body of a histozoon, not merely to one cell of the latter, unless we except the fertilized egg-cell; but there are many instructive analogies between tissue cells and protozoa. An excellent brief discussion of this side of the question is contained in a small volume on *Evolution* by Professors Patrick Geddes and J. Arthur Thomson, published about six years ago in the Home University Library series. The three leading divisions of Protozoa, namely, Rhizopoda, Infusoria, and Sporozoa, correspond to the three dominant phases of cell-life: amœboid, flagellate (or ciliate), and encysted (or passive). In the amœboid phase katabolism (biochemical wear and tear, destructive metabolism, proteolysis) and anabolism (biochemical synthesis, constructive metabolism, proteogenesis) are about equal; in the flagellate phase katabolism predominates; in the encysted phase anabolism prevails.

Phases of cell-life

It is not to be supposed that Histozoa have developed out of Protozoa as we know them to-day; both have diverged from a common source. In order to arrive at any degree of clearness on this point, it is necessary to project the mind back to an inconceivably remote period when it is possible to imagine the dawn of animal life on the earth breaking through the mists of eternity. This idea may be figuratively explained thus: Eozoa < Histozoa / Protozoa. There is a singular analogy between such a divergence as is here represented to have taken place during the first æon of earthly time and the segregation of germ-cells which takes place regularly during the development of a higher organism. The male and female germ-cells, being destined for each other, are known as gametes; when they unite to produce a fertilized egg-cell, the latter is a zygote; when the zygote develops by repeated cell-division into a new individual there ensues a differentiation between the tissue cells which form the *soma* or body, and the germ-cells, which carry on the hereditary processes: Zygote < Somatic cells / Germ cells. In a sense, therefore, we might regard the Protozoa as persistent germ cells.

Divergence of Protozoa and Histozoa

Gametes

Paramecium is a type of ciliate infusorian, easy to obtain amongst pond-weeds, and convenient to study. Though strictly unicellular, the nuclear apparatus consists of two portions lying side by side: a meganucleus, which presides over the vegetative life of the organism, and a much smaller micronucleus, which controls reproduction. *Paramecium* multiplies, under favourable conditions of food, light and temperature, at a great rate by simple binary fission. The two nuclei divide and the daughter nuclei separate towards opposite ends of the slipper-shaped body; then a constriction appears across the middle and soon two new paramecia break apart. At the optimum temperature (20° C.), *Paramecium* will divide twice in twenty-four hours (Maupas, 1888). By calculating the mean rate of binary fission from actual countings, under somewhat defective laboratory conditions, Balbiani (C. R. Ac. Paris, t. 50, 1860), found that a single *Paramecium* could give rise in forty-two days to 1,384,416 descendants. Putting the average length at 0.2 mm., these, placed in line, would

Division of Paramecium

cover a length of 277 metres. Under properly controlled laboratory conditions, L. L. Woodruff has succeeded in cultivating a pedigree race of *Paramecium aurelia* for seven years through 4,500 generations, without conjugation (Woodruff and Rhoda Erdmann: *Periodic Reorganization in Paramecium*, Journ. Exp. Zool., vol. 17, 1914, and vol. 20, 1916). From time to time there occurs a readjustment of the nuclear apparatus by an automatic process of "endomixis."

Pedigree race of Paramecium

Under natural vicissitudes there comes a time when, instead of dividing, paramecia conjugate in pairs, undergoing a temporary fusion during which they continue to swim about for some hours like Siamese twins. Whilst this is going on, the vegetative meganucleus becomes disintegrated and dissolved; and the reproductive micronucleus divides twice over, giving rise to four micronuclei in each conjugant. Three of these dwindle away and the remaining one becomes the generative nucleus in each conjugant; this nucleus then divides a third time to produce two *pronuclei*, of which one is migratory, behaving like a male gamete; the other stationary, behaving like a female gamete. Next follows an interchange of migratory pronuclei, which move over from one conjugant to the other across the bridge of union. Each conjugant now contains its own stationary pronucleus and a migratory pronucleus derived from its mate; internuclear fusion occurs and each conjugant finally possesses a single zygote nucleus. The mating paramecia now separate; the characteristic nuclear apparatus is regenerated by division from the zygote nucleus and a new epoch of binary fusion is inaugurated. In Paramecium it would appear that there is no regular recurrence of conjugation; it depends entirely upon the positive or negative stimulus of the environment. The natural food of Paramecium consists principally of minute flagellata and bacteria, which are swept into the mouth (cytostome) by the cilia lining the oral groove. As long as the food supply is continuously sufficient in quantity and right in quality, Paramecium will divide without conjugation. Woodruff's earlier method of treating his cultures consisted in constantly varying the concentration of the culture medium. Later he found that Paramecium can be reared indefinitely without conjugation in a 0.025 per cent. solution of Liebig's beef extract. If the environment does not yield the necessary motive for conjugation, it may be said to be neutral as regards that reaction.

Conjugation of Paramecium

Food of Paramecium

The history of the nuclear changes during conjugation was elucidated in 1889 by E. Maupas and R. Hertwig, working independently. Professor G. N. Calkins (*Protozoan Germ Plasm*, Popular Science Monthly lxxix, New York, 1911, pp. 568-580), states that the migratory pronucleus is smaller that the stationary pronucleus, and he suggests that the three successive micronuclear divisions which precede the interchange can be interpreted "as the reminiscence of a process of gamete formation, which obtained in remote ancestral forms." If this is correct, it means that the mode of reproduction in Paramecium and other ciliate infusoria is highly specialized. Conjugation is unknown in the life-history of *Amœba*, and there is no phase of encystment in that of *Paramecium*.

Vestigial Gametes

A. WILLEY.