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Annals and Magazine of Natural History
Series 4

ISSN: 0374-5481 (Print) (Online) Journal homepage: http://www.tandfonline.com/loi/tnah10

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**To cite this article:** Prof. Theodore Gill (1874) The number of classes of vertebrates, and their mutual relations, Annals and Magazine of Natural History, 13:73, 71-73, DOI: 10.1080/00222937408562439

**To link to this article:** http://dx.doi.org/10.1080/00222937408562439

*Nassa exilis*, Powis.

*N. panamensis*, C. B. Ad.

*Nassa complanata*, Powis.

*N. gemma*, Phil.
*N. cellaria*, Brit. Mus. A small variety.

*Nassa concentrica*, Marrat.

*N. concinna*, Reeve, sp. 82; not the *concinna*, Powis, Reeve, sp. 91.

*Nassa gaudiosa*, Hinds, is not the shell figured in Reeve under that name.

*Nassa Bronni*, Phil., is a variety, with the outer lip muricated, of *N. coronata*, Lam.

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## *The Number of Classes of Vertebrates, and their Mutual Relations.*

By Prof. Theodore Gill.

The mind, untrained in scientific logic, in its generalizations respecting the animal kingdom, if we may judge by the vague ideas elicited by inquiry and by the history of science, instinctively associates its subjects into groups determined by the nature of their habitat; and hence we have had the vertebrates differentiated into (1) those especially adapted for progression on land (Quadrupeds), (2) those especially fitted for progression through the air (Birds), and (3) those adapted for life in the water (Fishes); while the residue, not readily combinable with either of those classes, are tacitly overlooked, or, as the serpents, annexed as a kind of appendix to the Quadrupeds, because they most resemble certain of those animals—the lizards. It was therefore a great advance when Linnæus established a peculiar class (Mammalia) for the typical viviparous quadrupeds and the whales, and thus for the first time subordinated habitat and adaptation therefor to structure. While at the present day the ancient ideas have almost entirely disappeared from the system of nature so far as regards the terrestrial vertebrates, they are still to a great extent prevalent in the appreciation of the relations of the aquatic ones. For those vertebrates confounded by most naturalists under the name of Fishes are very dissimilar among themselves, and so much so even that the differences are more marked and radical than those between any of the superior classes of the branch. If, indeed, considerations of differences of structure are to guide us in the appreciation of the relations and subordination of animals, the current classification must be entirely changed, and the subordination of the highest groups, first suggested by Häckel, should be adopted with some modifications, while, as respects the combination of the "higher" or more specialized classes into superior groups, other principles should guide. One of the chief points to be reconsidered is the association of the Batrachians with Fishes rather than with the true reptiles. Although no

distinction may be possible between the first two when the class of Fishes has the wide range generally allowed, there is no difficulty in their discrimination with the limits here to be assigned to them. We may then group the classes as follows :—

On the one hand is *Branchiostoma* or *Amphioxus*, distinguished by the extension of the notochord (which is, of course, persistent) to the anterior end of the vertebral column, the attenuation of the spinal cord forward and its simple structure, the absence of auditory organs, the simple tubular structure of the heart, and the development of the liver simply as a diverticulum of the intestine.—This type is called by Häckel the subphylum *Leptocardia* or *Acrania*.

On the other hand are all the other vertebrates, which agree in the termination of the notochord behind the pituitary fossa, the enlargement of the spinal cord forward into a brain, the development of auditory organs, the division of the heart into (two to four) chambers, which in part (one or two) specially receive the blood, and in part (one or two) specially distribute it to the body again, and the differentiation of the liver as an independent and highly specialized organ.—This group is named by Häckel the subphylum *Pachycardia* or *Craniota*.

The numerous forms belonging to the last "subphylum" are also divisible into two great groups.

In one the skull has no cincture girdling the mouth, and consequently no lower jaw, there are no pectoral members or scapular girdle, and there is but one nasal sac, which has a median external aperture.—To this section belong the lampreys and hags, the representatives of the class of *Marsipobranchs*.

In the other, the skull has a cincture surrounding the mouth, its inferior portion being specialized as a lower jaw; they have (archetypically at least) a pectoral member and a shoulder-girdle developed; and there are two nasal sacs, each having an olfactory nerve distributed to an external aperture.—These vertebrates are again divisible into three groups or superclasses.

1. In the first (*Lyrifera*) the shoulder-girdle forms a lyriform or furcula-shaped apparatus, the scapulæ and their adjuncts of both sides being connected together below along the median line, and an air-bladder (sometimes lung-like) is typically developed (sometimes, however, atrophied) and (1) either connects with the œsophagus by a single duct or (2) is entirely closed. To this superclass belong the classes of Fishes and Elasmobranchiates.

2. In the second (*Quadratifera*) the shoulder-girdle is represented by the scapulæ and their appendages, which are limited to the respective sides, a sternum is differentiated, and instead of an air-bladder are two lungs, each with a special canal, which communicate with the pharynx. The lower jaw is compound and is articulated with the skull by the intervention of a special bone—the os quadratum. To this superclass belong the Batrachians, the Reptiles, and the Birds, the last two forming the group *Sauropsida*.

3. In the third (*Malleifera*) the shoulder-girdle is represented by composite scapulæ, limited to the sides or back; a sternum is

developed; respiration is entirely effected by highly specialized lungs communicating with a common trachea; and the lower jaw is composed of simple rami, and articulated directly with the skull, the os quadratum of the other vertebrates being converted into one of the auditory ossicles (the malleus). This superclass is represented by a single class—the Mammals.

The more these groups are studied in all their relations, the more natural do they appear.

As to other questions—that is, whether the true Fishes and Selachians are not separate classes, there is much to be said on both sides, and perhaps the arguments in favour of the class value of the Selachians may be even more weighty than those against them. If, indeed, the Birds and Reptiles are differentiated as distinct classes, similar rank can scarcely be consistently withheld from the Fishes and Elasmobranchiates. If I have heretofore hesitated, it is because of Dr. Günther's very adverse views.

Without prejudice to the reconsideration of the question as to the systematic value of the group of Selachians or Elasmobranchiates, the classes of vertebrates may then be distributed, in a descending series, as follows :—

Branch VERTEBRATA.
- A. Subbranch CRANIOTA.
  - Superclass MALLEIFERA.
    - I. Class Mammalia.
  - Superclass QUADRATIFERA.
    - (Sauropsida.)
    - II. Class Aves.
    - III. Class Reptilia.
    - (Batrachopsida.)
    - IV. Class Batrachia.
  - Superclass LYRIFERA.
    - V. Class Pisces.
    - VI. Class Elasmobranchiata.
  - Superclass MONORRHINA.
    - VII. Class Marsipobranchia.
- B. Subbranch ACRANIA.
  - VIII. Class Leptocardia.

The most nearly related pair of classes are those of Birds and Reptiles; and preeminently the most homogeneous is that of Birds, all the living representatives of which seem to be members of a single order (which may be distinguished by the name Eurhipidura), and at most divisible into two suborders, the Carinatæ and the Ratitæ. Other orders are represented by extinct types, viz. Saururæ and (if the vertebræ are peculiar to the group) Odontornithes.—*Abstract of a communication to the National Academy of Sciences, made* Oct. 29, 1873. *Communicated by the Author.*