

**guide to
LIVING
AMPHIBIANS**

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2/ Guide to
LIVING AMPHIBIANS



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First published 1981 by
THE MACMILLAN PRESS LTD
London and Basingstoke
Associated companies in Delhi Dublin
Hong Kong Johannesburg Lagos Melbourne
New York Singapore and Tokyo

Filmset by Vantage Photosetting Co. Ltd.
Southampton and London

ISBN 0 333 30749 6 (hard cover)
ISBN 0 333 30601 5 (paper cover)

Printed in Hong Kong

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Guide to
LIVING AMPHIBIANS

Previously published titles in this series

Guide to Invertebrate Animals (Second Edition)

Guide to Living Reptiles

Guide to Living Birds

Guide to Living Mammals (Second Edition)

Guide to Living Fishes

Preface

The Guide to Living Amphibians completes this series of six volumes which also includes guides to the invertebrates and the living fishes, reptiles, birds and mammals, and thus covers the entire animal kingdom. In common with the others, this volume uses an annotated classification to give a basic understanding of the structures and relationships within the group, a concept that has been successfully developed over many years in the training of students.

Among the vertebrates alive today the class Amphibia is one of the smallest and least well known. Amphibians were the first tetrapods and even the modern forms retain strong similarities in structure, physiology, behaviour and life history with their fish forebears. Something of this is shown in the chapter on tetrapods which links this guide with the Guide to Living Fishes.

Modern amphibians are very different from their ancestors that first climbed onto land in the Devonian Period and became the dominant land animals in the Carboniferous. Salamanders, caecilians, frogs and toads, are mostly relatively small with the ancestral dermal armour lost and the internal skeleton modified and much reduced. They are recognised as amphibian mainly from their life cycles, for most are tied to water for breeding, laying jelly-encapsulated eggs in water or damp places and having aquatic larvae. Although none of the extant groups is well represented in the fossil record, all evidently arose early in the Mesozoic when the break up of the single supercontinent, Pangaea, was beginning. As a result, in spite of their limited powers of dispersal and the fact that salt water

is a major barrier, amphibians are found on all the tropical and temperate land masses. Nevertheless some families are in decline and others appear to be adaptively radiating, so that there are interesting patterns of distribution which are shown in the maps that accompany the families.

There are few up-to-date textbooks on the Amphibia. Some of these and some useful recent papers giving an entry into the literature are mentioned in the introduction and on page 16. The guide has no index as this function is served by the list of contents, which sets out the classification used, the glossary, by the lists of generic and common names and by the cross-referencing of text and figures through page numbers in brackets.

We again thank Mrs Margaret Clarke for the preparation of the typescript for lithography and Phil Brooks for the drawings of the animals. We are particularly indebted to Dr Richard C. Tinsley for much help and discussion about the classification of the Amphibia and for advice on the many problems this has raised. However, the interpretations and the responsibility for errors are ours.

JEW

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London, March 1980

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1 Introduction

Living amphibians and reptiles are comparatively small groups of vertebrates which it has become common practice to treat together as the study of herpetology, particularly for teaching purposes. The reptiles arose from the amphibians in the Upper Carboniferous Period and at that time the two groups were structurally so similar that it is difficult to distinguish between them. However, this similarity does not extend to their living representatives. The amphibian body has undergone much structural reduction. All living amphibians are highly specialised and have diverged considerably from the primitive form. The same applies to many of the living reptiles, notably the snakes, although some reptiles, the turtles, crocodiles and the tuatara, have retained an essentially primitive structure. Adaptive radiation in the modern reptiles is chiefly structural and behavioural, whereas in modern amphibians, particularly the anurans, it is mainly reproductive and involves various ways of circumventing the problem of returning to water to breed. The two groups, therefore, exemplify different aspects of zoology. It is for this reason that the living amphibians and the living reptiles have each been treated in a separate guide in this series.

The guides to the living members of the tetrapod classes, amphibians, reptiles, birds and mammals, differ from the guides to invertebrates and living fishes in an important respect. In general the tetrapods or land-living vertebrates are more completely known in terms of extant species than any other group of animals. It

therefore seemed desirable that the tetrapod guides should be comprehensive and include all the families into which the four classes are divided. This is not to say that all familial names proposed by different authorities have been quoted, because the approach to classification used here has been conservative. Many families distinguished here have been subdivided into two or more families by different people at various times, but such splitting is difficult to support in terms of sets of matching characters, often because the information is not available. The invertebrates and the fishes are too extensive and too complicated to be treated in this way within the scope of the present series of guides. Such groups as the insects and the teleost Acanthopterygii, for example, would require separate volumes.

Classification of the Amphibia

The state of the classification of the Amphibia is less well advanced than that of the higher tetrapods. Considerable research in the last twenty years has done much to clarify the relations between the different amphibian families, particularly in the most difficult group, the Anura. New characters and old have been investigated and the weight that should be given to each has been computed through numerical taxonomy by A.G. Kluge and J.S. Farris (1969) in Systematic Zoology, 18, 1-32. A fully satisfactory system is elusive, however, and there is much controversy among authorities even about the levels of the higher taxa. To some extent this applies to the reptiles, birds and mammals as well, but to an altogether lower degree. The classification of these classes, due, probably, as much to the greater number of systematists in these fields as to any inherent difficulties in the classes, has reached a stability that amphibian systematics has yet to attain.

In constructing this guide to the living amphibians it has been impossible to follow completely any established pattern of classification, though parts of many have been incorporated. It has been necessary to compile sets of

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matching characters and assess their value in the light of knowledge that the resulting classification is not quite like any that has been previously proposed. For this no apology is made. The aim has been to achieve a functional arrangement not greatly at variance with current phylogenetic opinion. The classification of the Apoda is simple, but perhaps this is an illusion and due to paucity of information on these burrowing tropical forest animals which are difficult to find. The classification of the Urodela is also relatively straightforward, although this interpretation differs considerably from that of K.R. Porter (1972) Herpetology, W.N. Saunders Company, Philadelphia, London, Toronto, but less so from that of C.J. Goin, O.B. Goin and G.R. Zug (1978) Introduction to Herpetology, 3rd edition, W.H. Freeman & Company, San Francisco. The Anura are a problem of greater magnitude, as can be seen from I. Griffiths (1963) 'The phylogeny of the Salientia', Biological Reviews, 38, 241-292, Kluge and Farris (loc. cit.), J.L. Vial (1973) Evolutionary biology of the anurans, University of Missouri Press and W.E. Duellman (1975) 'On the classification of frogs', Occasional Papers of the Museum of Natural History, University of Kansas, 42, 1-14. The classification of the Anura used here is in general, but not precise, agreement with those proposed or implied in these works, which also provide bibliographies on the Amphibia. The best general texts on the Amphibia are G.K. Noble (1954) The biology of the Amphibia, Dover Publications Inc., New York, (although the classification is out of date), and the works by Porter and Goin et al. (loc. cit.).

Use of the Guide

As in the other guides in this series, a system of matching characters has been used throughout. The list of characters diagnostic of the amphibians on pages 17 & 18 deals with the same structures in the same order as those for the other vertebrate classes, see, for example, pages 25-26 of the Guide to Living Reptiles. Within the

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Amphibia, matching characters for each order, Urodela, Apoda and Anura, are arranged so that the differences and resemblances between the orders become immediately apparent, and similarly for the suborders within an order and so forth. In these sets of matching characters, some will be of greater importance for diagnosis than others. These have been marked with a black spot. Many of the characters are illustrated and reference to the figures is given by the page numbers in brackets after the characters. Cross-reference is also given in the glossary and in the lists of examples quoted by scientific and common names. The relationships between the groups are shown schematically and there are sketches of typical members and distribution maps of the families. This guide will be found helpful in a number of ways a few of which are listed below.

- It provides a conspectus of the recent amphibians from which the range of diversity can be appreciated.
- Schematic diagrams show the basic classification in terms of the relationships thought to exist between the groups.
- The reasons for the classification are evident from the lists of matching characters. Here negative as well as positive characters are given and irrelevant features omitted.

2 The Tetrapods

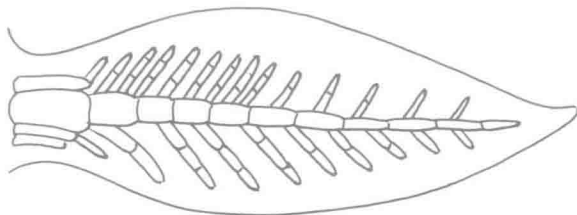
The vertebrate transition from life in water to life on land involved two major initial requirements, first the breathing of air and secondly a means of locomotion over the rough land surface where friction is high. In a sense the primitive fishes were preadapted for breathing air since they already had lungs and some groups, judging from their modern counterparts, the lungfishes, would have used their lungs for air breathing. Locomotion on land is another problem for which the typical, unmodified, paired fins of the fish are not suitable. The body of the fish in water is virtually weightless, but on land in the less dense medium of air this is not so and the body requires to be supported. To achieve this the paired fins became modified into legs with hands and feet each with five digits. The legs are four movable props with the centre of gravity of the body between them, hence the name tetrapod. This is not the only method of achieving locomotion on land as the legless lizards and snakes show, but it is highly effective and has also been used extensively by the arthropods.

The pentadactyl tetrapod limb evolved in the Devonian Period from the fleshy, leaf-shaped fin or archipterygium of the rhipidistian fishes. This type of fin is best seen today in the Australian lungfish, Neoceratodus, one of the nearest living relatives of the Rhipidistia. It is characterised by a long, jointed, central axis of bones articulating with the limb girdle and having symmetrically arranged side bones. The colonisation of the terrestrial habitat was evidently a gradual process. The first

tetrapods, the Devonian amphibians, apart from air-breathing and legs, were still almost completely fish-like and probably spent most of their life in fresh water. Here they evidently had significant advantages over many of the contemporary fishes in that they could come out on land when necessary and waddle from pond to pond. The process of emancipation from water is enacted today in the life histories of many of the modern amphibians which begin virtually as a fish (the tadpole), breathing with gills, and end as four-footed, air-breathing land animals.

A concomitant of life on land is the loss of water through evaporation. This problem was not solved immediately and has still not been solved by most Amphibia. It was left to the reptiles to achieve an acceptable measure of waterproofing of the skin (still not complete in some) and to provide through the shelled egg and the embryonic membranes a means of protecting the embryo from mechanical damage and desiccation. Once the tetrapods were divorced from the necessity of returning to fresh water to breed the way was open for the colonisation of the dry lands, the evolution of the mammals, the conquest of the air by the birds and the bats, and also the reinvasion of the sea by the ichthyosaurs, whales and others.

The characters of the Tetrapoda are given here for comparison with those of the Pisces in the Guide to Living Fishes.



fin of Neoceratodus showing skeletal structure

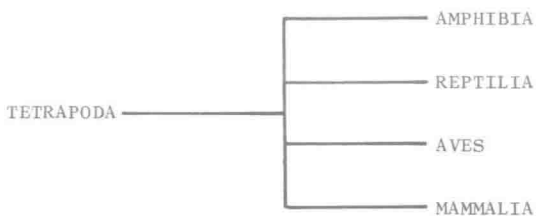
Superclass Tetrapoda

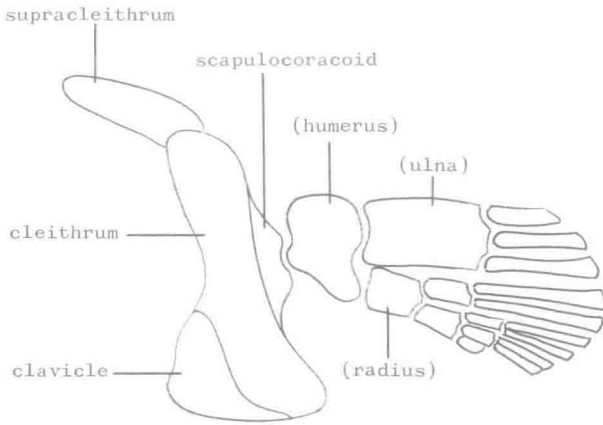
Gnathostomata in which:-

- 1. The body is typically without scales (Amphibia), covered with epidermal scales (Reptilia), feathers (Aves) or hair (Mammalia). (19)
- 2. The paired appendages are pentadactyl limbs. (8, 81)
- 3. The head is typically carried on a neck, and capable of independent movement, except in the Amphibia. (20)
- 4. Internal nostrils are present opening into the buccal cavity. (20)
- 5. The snout region of the skull is well developed, and the posterior skull table is reduced in size. (11)
- 6. A lachrymal duct, associated with the eye socket, is present in terrestrial forms but has been lost in aquatic tetrapods. (11)
- 7. Respiration takes place mainly through lungs. (12, 25)
- 8. The blood vascular system shows varying degrees of development of a double circulation, which separates pulmonary and systemic blood. (28)
- 9. Typically the visceral arches are reduced to a 'hyoid' bone. Internal gills may be present in primitive tetrapods but not in higher forms. (26)
- 10. Typically, there is a movable tongue in the floor of the mouth. (20)
- 11. An allantoic bladder is present in the adults of amphibians and in the embryos of reptiles, birds and mammals. (118)
- 12. The members are essentially terrestrial, although some groups are secondarily aquatic.

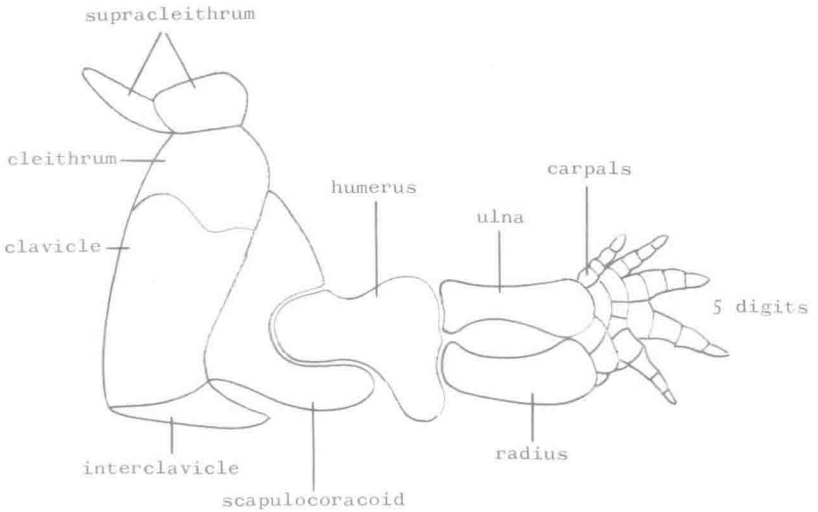
SUPERCLASS

CLASS





skeleton of a crossopterygian pectoral girdle and fin



skeleton of an early tetrapod pectoral girdle and limb