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CONTRIBUTIONS TO CONCHOLOGY.

No. 11.

HINTS ON THE GEOGRAPHICAL DISTRIBUTION OF ANIMALS,
with Special Reference to the Mollusca. By C. B. ADAMS.
October, 1852.

Areas of Species.

1. Each species occupies one geographical area only.
2. Species 'introduced' by human agency from one area into another are obvious exceptions.

3. The literature of Zoology, especially of Conchology, conflicts with the first proposition (§ 1) in a great number of examples, chiefly on account of the common practice of publishing statements of habitats, without thorough scrutiny into their authenticity.*

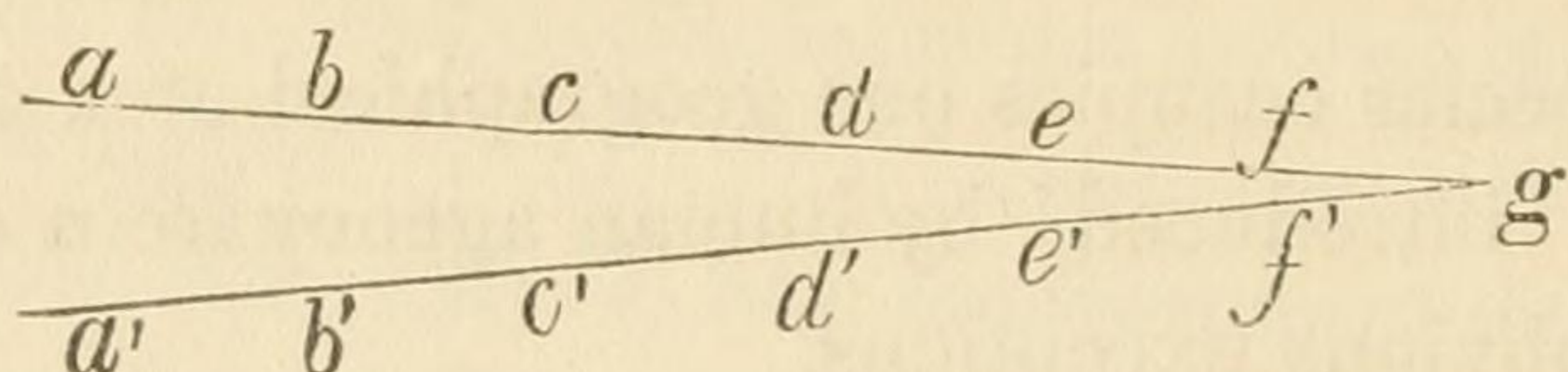
4. Inasmuch as natural types are of all grades of value (v. p. 191), so that some are of a little less and others of a little more than the average value or importance of a species, the difficulty which hence arises in the discrimination of species must cause some apparent or doubtful exceptions to our first proposition. The differences between some types, which inhabit distinct areas, is slight: and other types exist, between which differences have not yet been detected, although they may actually exist.† If such differences prove to be absolutely constant, the types will generally be regarded as good species. But if other-

* We have elsewhere proposed to distinguish original from hearsay testimony, by an exclamation mark. (!)

† Of such types Dr. Gould "admits it as an axiom in Zoology," that they "should be assumed as different, until their identity can be proved."—*Introd. Moll. Expl. Exped. p. XI.*

wise, the question of their specific value may ever remain in doubt.

5. But if we admit the doctrine of species above referred to, a few examples of identical types in distant areas are not exceptions to the general plan of nature, but an integral part of it. The general fact may be thus stated: a number of pairs of analogues from two distinct provinces may be so arranged, that the amount of difference between each two shall successively diminish from very distinct species to species less distinct, and then to species scarcely distinguishable, until at length the series shall terminate in two forms quite indistinguishable from each other, that is, in one species. In other words, if the pairs



be arranged on both sides of an angle, as in the accompanying figure, with the amount of difference expressed by the distance across the angle, as from *a* to *a'*, *b* to *b'*, &c., the vanishing point of the differences will be in an identical type, as *g*.

6. The areas of species vary from a few miles to several thousand miles in diameter. There are few which exceed three or four thousand miles. But a great number exceed two thousand miles; and, with the exception of insular terrestrial faunæ, a large majority of the areas exceed one thousand miles in diameter.

7. The areas of insular terrestrial species, excepting those which have the power of flight, do not usually exceed the islands which they inhabit, if the islands are thirty to fifty miles distant from each other. As to islands which are separated by one hundred miles or more of water, the examples of species common to two or more are rare.

Zoological Provinces.

8. The geographical coincidence, more or less exact, of many specific areas constitutes a zoological province.

9. Zoological Provinces, except those which are insular, are for the most part three or four thousand miles in diameter.

10. The fact that one fauna extends through all longitudes in the Arctic regions is not an isolated fact, as has been supposed. It results from the diminution of the degrees of longitude, so that the Arctic zoological province extends through all longitudes, merely because it has the ordinary dimensions of a zoological province. On the other hand, the three great southern points of land, Patagonia, South Africa, and New Holland, are too remote from each other to be comprised in one zoological marine province.* But it may be predicted, that only one zoological province will be found in the Antarctic zone.

11. The difference of aquatic, terrestrial, and aerial habits has the most important connexion with geographical distribution. Next in importance is climate. Next, and of much less importance, is zoological affinity. The influence of zoological affinity is seen in the fact that the area of one group of species sometimes does not coincide with that of another group, of the same habits in respect of climate and station; as the Melanidæ and Limniadæ of the United States. The same species of Limniadæ extend through the Western, Middle, and Eastern States, but the Melanidæ do not enter any of the Eastern States. Their eastern boundary is therefore four to five hundred miles west of the eastern boundary of the Limniadæ.

12. The figure of a zoological province depends chiefly on the distribution of land and water in connexion with latitude.

13. Several distinct insular terrestrial zoological provinces

* The separation by water, irrespective of great distance, would alone give them distinct terrestrial faunæ.

are often comprised within a single marine province. Thus the terrestrial faunæ of Cuba, St. Domingo, Porto Rico, and Jamaica, are distinct from each other; and the same is true to a great extent of the West Indian Islands generally; those of the Bahamas and Bermudas are also distinct. But a single marine province extends from the Bermudas to the southern part of Brazil.

14. The attempt to divide up the earth into one set of zoological provinces for all animals, whether aquatic or terrestrial, is therefore futile.

15. The converse of proposition 13, in respect of bodies of water surrounded by land, does not hold true. In any one lake or river, the proportion of species peculiar to it is small. This may be said to be owing to the means of communication in the case of rivers emptying into a lake or chain of lakes. But the same extent of distribution is equally common in respect of unconnected rivers and isolated ponds. It may, therefore, be inferred that the original plan of creation was different from that of the insular species.

16. Because change of climate is always nearly or quite in one direction (N. and S.), and is always more or less gradual, differences of climate do not cause several zoological provinces of one sort to be comprised within zoological provinces of another sort, but merely render their boundaries indistinct.

17. Because zoological affinities have some connexion with distribution (§ 11), indefiniteness of boundaries will result from the attempt to comprise any considerable portion of the animal kingdom in one scheme of zoological provinces. Absolutely distinct, that is, linear boundaries exist only between single species, except that the boundaries between terrestrial and insular faunæ are linear, and those between indistinct species are necessarily ill defined.

The cause of indefiniteness of boundaries is to be found in the fact that the areas of different species do not exactly coincide; although sometimes several nearly coincide, as at

Cape Cod in Massachusetts, where many marine species meet from either side, but do not pass the boundary.

In general, the boundaries of zoological provinces which are not insular, are more indefinite, in proportion as we include a greater part of the animal kingdom in one set of provinces.

18. Analogues are usually more numerous in adjacent or approximate zoological provinces than in those which are remote from each other. Thus there are more analogues in the Caribbean and Panama marine provinces than in the Caribbean and Indian Oceans. The terrestrial faunæ of Cuba, St. Domingo, Porto Rico, and Jamaica, contain many more analogues than either of these islands compared with the Philippine Islands.

Areas of Genera and of more Comprehensive Groups.

19. The proposition respecting specific areas (§ 1), may be applied to groups more comprehensive than species, but with more and more qualification, as the groups are more and more comprehensive, until at length it fails entirely; and the areas become greater, until at length the whole planet becomes a single area.

Thus many genera inhabit each a single area, as *Cylindrella*. Some genera are chiefly restricted to a single area, as *Clausilia*.* Others are cosmopolite. Some families, a few orders, and at least one class (Reptiles) are restricted each to one area. Tropical regions constitute a single area for several natural families and orders in both the vegetable and animal kingdoms. The area of the Cypræidæ consists of the tropical zone with adjacent parts of the temperate zones. The area of the class of Reptiles comprises all the warm and temperate regions of the earth's surface.

The vanishing point of this proposition is in the truism—that the area of the whole animal kingdom is the whole of the planet.

* See article following, on the Clausiliæ of America, by Thomas Bland, p. 224.

Relations of the subject to theories of the origin of species.

20. It should not be assumed, before it has been proved, that each species has originated in a single central point in its area, nor that physical agents have been the principal causes of the existing phenomena of distribution.*

21. Natural agents may somewhat enlarge the area of a species, but are not likely to transplant a species into a distinct remote area. Thus if currents or locomotion transport a species into a new habitat, the same species will be likely to occur at places intermediate between this new habitat and the original area. Consequently the effect of physical causes must usually be limited to the enlargement of specific areas.

22. The small areas of insular terrestrial species and large areas of continental species suggest the theory of centres of creation; for it may be said that the insular species would have spread over equally large areas, if they had not been restrained by water. But although such a theory accounts for these facts, the theory is not proved, because the facts are as satisfactorily accounted for by another theory, viz. that the original plan of creation was different in the two cases.

23. The fact, that the number of species in an insular province is generally much greater, proportionally to the area of the provinces, than in a continental province, proves that the original plan of creation was different. Thus Jamaica contains more known species of terrestrial Mollusca than the whole of North America, from the Isthmus to Melville Island. It is indeed probable that there are more unknown species in Mexico and in Central America than in Jamaica; but it is not probable that enough remain undiscovered materially to affect

* Some writers account for the facts of distribution, and for the introduction of *varieties* of species by physical agents, while they designate such a method of accounting for *species* and genera as atheistical. But it should ever be remembered that physical agents are only the agents of the Divine will; consequently such opinions are not atheistical.

the proportion. The species of Cuba, St. Domingo, and Porto Rico are but partially known; yet they confirm the general proposition. The same is true of the land shells of the Philippine Islands, and of the Sandwich Islands.

24. The distribution of fresh water continental species also proves that the original creation of the insular species was on a different plan from that of the continental species (§ 15).

25. If large groups of such islands, as the West Indies, should be united in a common area of dry land, then, according to the theory which accounts for the facts of distribution by actual dispersion from centres, there would be zoological provinces containing five to tenfold as many species as any which now exist.

26. The geological fact, that continents by submergence become islands, and that islands by emergence become continents, does not affect the foregoing reasoning, because such changes require an amount of time exceeding one geological period, during which time there is a change of faunæ.

27. The original creation of many individuals of a species in different parts of its area has been the principal cause of the present facts of the distribution of the individuals of the species. Physical agents have exerted only a modifying agency.

28. In organic nature, principles are not observed throughout any department, with mathematical uniformity; on the contrary each idea appears with various degrees of development from its maximum to its minimum, and often to a vanishing point. Hence it is probable that the introduction of species has been accomplished by the creation of original individuals varying in number from a great multitude to a few. In the same manner the actual numbers of the individuals of species now range from inconceivable profusion to extreme rarity.

Relations of the subject to geological reasoning.

29. Such insular faunæ, as have been described in § 7 and § 13, prove that the islands which they inhabit, have been

geographically separate since an era anterior to the introduction of the existing species. But this conclusion does not depend on the assumption that the species would have dispersed themselves over several islands if they had not always been restrained by water; but on the fact that such small zoological provinces exist nowhere on continents.*

30. The occurrence of a very *few* identical species on different islands, or on islands and the mainland, does not prove the union of such land since the existence of the species, because such a distribution may have been caused by the accidents of dispersion, or (§ 27) by independent creation.

31. If the time, when any islands were once united, can be proved geologically to have been more remote than the introduction of existing species, any facts relating to the distribution of the existing species cannot prove the union of such islands. This is a truism, but it seems to have been sometimes forgotten.

32. The occurrence of many species common to different islands, in some parts of Polynesia, renders it probable that such islands have constituted one island since the existence of these species.

33. The frequent occurrence of analogues and the prevalence of generic or subgeneric types in some islands do not prove the former union of these islands, but may indicate their greater proximity at a former period (v. § 18).

34. An apparent exception to § 18 is mentioned by Dr. Gould (Introd. Rep. Moll. Expl. Exped.). The Samoa and Friendly Islands are more intimately related zoologically to the Society Islands, than to the Feejee Islands, although the latter are much nearer. Hence we may infer the greater magnitude and proximity to each other at some former period of the Samoa, Friendly, and Society Islands.

The above hints have been hastily written down. They may

* The very limited distribution of certain tribes of animals is not an exception to this statement, which has reference to the general fauna of a country.

require modification: certainly much is to be done in giving the subject precision and elaboration of details.

In perfecting the science of the geographical distribution of animals, Conchology may, with the greatest facility, render important aid, in consequence of the ease with which great numbers of specimens are collected, transported, and preserved.

Catalogue of the TERRESTRIAL SHELLS OF ST. THOMAS, West Indies. By THOMAS BLAND, F. G. S., London. Oct., 1852.

The study of the land shells of the West India Islands has proved the existence of several distinct terrestrial insular faunæ, within the area of the marine Caribbean zoological province. Professor Adams collected in Jamaica about 350 species of land shells, of which three or four per cent. only have been found elsewhere. Increased attention is being devoted to the land shells of the other Islands, and we now contribute a list of those which inhabit St. Thomas.

It should be explained that the numbers printed within brackets, after the numbers of the species, refer to a list in the hands of several gentlemen resident in St. Thomas and elsewhere, who have collected the shells of that island, and that specimens, with corresponding numbers, have been deposited in the cabinet of Amherst College, Mass., U. S. Specimens of the undetermined species (excepting only No. 13) have been sent to Mr. Hugh Cuming, London, who forwarded them to Dr. Pfeiffer of Cassel for description. We hope to publish in a subsequent number of these "Contributions" the names, with references to the descriptions, by Dr. Pfeiffer.

The following shells have been described as inhabiting St. Thomas, but we believe erroneously.

Helix depicta Grat. St. Thomas and New Orleans; Grat. Pfr. Mon. Hel. Viv. No. 28.

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Geographical Distribution of Animals. 209
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Catalogue of the Terrestrial Shells of St. Thomas, W. I. 215
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