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Contributions to the Knowledge of the Zoogeographical Situation in the Near and Middle East[1]

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A zoologist[3] coming from the north and travelling in the regions south of the Toros mountains feels himself suddenly in a foreign country, among a fauna unfamiliar to him from the central or eastern Anatolian steppes, or from the mountainous regions of northern, eastern, or western Anatolia. Animals such as driver ants, fruit-eating bats, the mysterious darter, bülbüls, soft skinned tortoises, a large monitor, the mongoose, the saphan of the Bible, and many other species well known in Palestine find their northern limit on the southern slopes of the Toros mountains. We have good reason to assume that these species are newcomers in the south Anatolian fauna, having intruded into the north as late as the end of the glacial epoch. The specific and racial identity of many of these elements, with their congeners in Palestine and farther to the south, in Africa or in India, proves this fact.

On the other hand, as a result of a movement towards the south in the glacial (pluvial) periods, some species that are widely distributed in Anatolia and even more in the north, e. g. in the Caucasus, the Balkans, Alps or Central Europe, still exist in Palestine. Representatives of this element of more northern origin are, among others[4], the fire salamander, *Salamandra salamandra*, the newt *Triturus vittatus*, in earlier times the roe deer, and even some freshwater fish like *Alburnus*, *Rutilus*, and *Cobitis*. Other intruders of northern origin, the Angara element, arrived together with the forms prefering cold and humidity mentioned above. The Angara element confronts us with species of the cold steppes in eastern Siberia which in glacial times easily gained distribution towards the west and from there also to the south. Grasshoppers of the genera *Stenobothrus* and *Chorthippus*, well represented in Anatolia, in the steppes as well as in the high mountainous regions, can be quoted here. They can be found in some forms as far to the south as Palestine.—The loach, *Cobitis*, mentioned above, even reached Abyssinia, together with some other animals of palaearctic origin, Carabid beetles for example, and an earwig of the *Forficula tomis* group, which are mostly confined today to the high mountain regions of east Africa.

The southern movement to Africa in glacial-pluvial times was facilitated by some land-bridges between the palaearctic and aethiopian regions, of which the one going through Syria and Palestine seems to have been very important. As a general rule we can state that there is a gradient from north to south in such a way that the palaearctic forms become rarer the further we go towards the south. Today there are some discontinuities in this gradient caused by local ecological situations in certain regions that were passable in former periods.

An inverse gradient exists from south to north for tropical elements, and in this case again local ecological reasons rather than historical ones seem to have played the deciding role for the absence of some forms, where their existence could be expected. For example, the fact that no mouthbreeding Cichlid fish can be found in the lake of Antiochia, whereas they exist in Aleppo, may be caused not by the restricted mobility of these fish, but by some special ecological factor not known to us as yet.

This exchange of representatives of land and freshwater faunas of different origin, the one coming from the modern tropics, the other developing in the Palaearctic, began in the Pliocene. In this geological period the last communication between the Mediterranean Sea and the Indian Ocean, the so-called Syrian-Iranian Sea, retired completely, allowing the migration farther to the south, and conversely to the north, of land and freshwater animals. Until the desiccation of the Syrian-Iranian Sea, the Anatolian fauna developed primarily as a part of the palaearctic fauna. BODENHEIMER suggests[1] in a more special sense that a great part of the Anatolian fauna in the Tertiary derived from what he

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[3] The results presented above are, to a great extent, based upon new records obtained in the course of many excursions into different regions of Anatolia. The material help liberally granted by the Rectorate of the University of Istanbul and the Decanate of the Faculty of Science facilitated these scientific trips. In the course of our travels we found the local State authorities of the greatest understanding and readiness to help whenever required. I wish to express to them our gratitude in the name also of my collaborators who participated in these excursions. Wherever we came we were deeply impressed by the generous hospitality with which we were honoured even in the most remote villages of the country. Our task could not have been completed without the sincere interest shown by many private people all over Anatolia.

[4] F. S. BODENHEIMER, *Animal Life in Palestine* (L. Mayer, Jerusalem, 1935).

[1] F. S. BODENHEIMER, *Animal Life in Palestine* (L. Mayer, Jerusalem, 1935).

calls the Atlantic fauna, in which the Mediterranean region and some of the Atlantic islands are to be included. In fact, there is a most remarkable similarity in the composition of the faunal elements in Anatolia, the peri-Mediterranean and the sub-Mediterranean regions, especially in groups with restricted mobility like millipedes, woodlice[1], and also others. Families of animals of slow mobility, active or passive, such as the millipedes, offer an excellent material for historical zoogeography[2]. In contrast to the millipedes of Anatolia, which show preponderant Palaearctic, Mediterranean or sub-Mediterranean relationship, those of Palestine reveal relations rather with Africa by the presence of Spirostreptids completely absent even in the most southern regions of Turkey. Although the Mediterranean and sub-Mediterranean element is well represented in the Anatolian millipedes and other sedentary groups, we must keep in mind that just such Anatolian species with restricted active and passive mobility have clear faunal relations not only with the west, but also with the east of the Palaearctic, even as far as China and Japan. Thus it seems we are justified in seeing in the older faunal elements of Anatolia members of a widely distributed fauna of the warmer Tertiary which once occupied a nearly continuous area in the whole Palaearctic. This fauna differentiated in the course of millions of years into forms representing one another geographically and was partly destroyed, partly driven back into refuges as a result of the progressive climate changes with the approach of the Quaternary. Many land and freshwater genera of this palaearctic fauna of the Tertiary do not exist in Siberia today, from whence refuge into a more moderate climate was impossible. Anatolia offered such refuges, one in the Aegean and western Anatolian zones, the other in eastern Anatolia. These two refuges were separated from one another by high mountains in the north and in the south, and by a large freshwater lake or a system of lakes which covered an area as great as that from the sources of the Great Meander to the eastern border of Asia Minor. Although Anatolia towards the end of the Tertiary was raised up from nearly sea-level to an altitude of approximately 1000 meters, and in spite of the postglacial steppification of central Anatolia on the one hand and of the highlands around Mt. Ararat[3] on the other, the majority of its animals are forms of the palaearctic Arboreal. They are settled there since the Tertiary or at least since the Quaternary. With the amelioration of the climate in postglacial times, many species of the latter group reoccupied the territories in central Europe where they were lost in the glacial period. As was mentioned above, the pumping action of the glacial period was of high importance for the mixing of northern species with the fauna of Syria, Palestine, and Africa in the South of the Sahara.

Even though the Anatolian fauna shows clear relations with that of the Palaearctic, it must be admitted that some of its species do not fit in with this rule. These forms cannot be regarded as members of a more southern fauna which arrived in southern Anatolia in the glacial epoch; it even seems very doubtful whether these forms have come into Anatolia only after the desiccation of the Syrian-Iranian Sea in the Pliocene. I should like to mention here only some examples of these old elements, which may be called Gondwanian forms. They show faunal relations between Anatolia and regions far remote in the south, these regions being separated from the major part of the Gondwana continent in such early periods as the Secondary or the beginning of the Tertiary. Among the Anatolian millipedes the genus *Melaphe*[1] is to be discussed. Its area of distribution includes Albania, Thrace, Anatolia, Mauretania, and Abyssinia. The generally low mobility of millipedes and the ecological needs of *Melaphe* in particular make it improbable that the distribution area of the genus is the result of migrations in the near past. If we add that the nearest related genus to *Melaphe* is *Karakodesmus* in Venezuela, it sounds preferable to describe *Melaphe* as an ancient type of Gondwana origin. The same interpretation can be given to the near relationship of the blind and cavernicolous beetle *Cereaxina troglodytes* of south Anatolia[2] with the highly specialized and myrmecophilous genus *Lioclemmus* of Madagascar. The relationship of a Mediterranean and Anatolian genus of locusts, *Saga*, to genera in South Africa and Australia are arguments under the same heading. Finally the remarkable case of the wingless earwig genus *Pseudisolabis*[3] may be mentioned: This genus has one species in New Zealand, which was separated from Australia in the Mesozoic, some others in Australia, Malaya, India, and a new one recently described from western Anatolia. The presence of members of these Anatolian genera in widely removed and early separated regions of the southern hemisphere indicates the great phylogenetic age of these forms. But on account of the rareness of these examples and our defective knowledge of geological relations in the remote past, we cannot as yet work out the history of such species in more detail.

Our information is better in the case of the immigrants into Anatolia from the south during the Pliocene. The best known facts about this faunal migration are those concerning the distribution of freshwater fishes from India to Anatolia and also to Africa. The African freshwater fish fauna contains a group of forms with clear relations to South America, besides an old and

[1] K. W. Verhoeff, Rev. Fac. Sci. Univ. Istanbul [B] *5*, 1 (1940); *6*, 223 (1941); Zool. Anz. *136*, 35 (1941).
[2] C. Kosswig, C. r. Soc. Turque Sci. nat. *10*, 31 (1943).
[3] H. Louis, Geograph. Abh., 3. Reihe, fasc. 12 (1939).

[1] C. Attems, Graf v., Zool. Anz. *144*, 234 (1943.)
[2] R. Jeannel, Ann. Soc. Entomol. France *103*, 159 (1934).
[3] M. Burr, Proc. Roy. Entomol. Soc. *16*, 60 (1947).

endemic element of Mormyrids, bichirs, Phractolaemids, etc. As a result of a long divergent evolution after the early isolation of Africa from South America by the Atlantic Ocean, these elements are systematically considerably removed from one another. A third group of African freshwater fishes has very close systematic relationship with those of India, for instance the genera *Barilius, Discognathus, Barbus, Clarias, Mastacembelus*, and many others. The generic identity of this third group in India and in Africa supports the hypothesis that these elements were exchanged lately, not earlier than in the Pliocene. There are good reasons to suppose that a more indirect route—the north Arabian-Syrian—was used for the invasion of Indian genera into Africa. This means that the tropical Indian fishes passing Syria and north Arabia came into the neighborhood of Anatolia, which they entered freely. Some of these forms, e.g. an endemic subgenus of *Tylognathus*[1] in western Anatolia, are still remnants of this tropical invasion from India. The greater part of these Indian invaders went further to the south, leaving their traces in Palestine too. The reason why the invasion was unilateral and why no African forms migrated in the inverse direction into India cannot be answered today. But it seems worth mentioning that such African forms as reached western Asia are also known from Palestine and Syria; this means that these forms also took the longer northern way instead of the direct route to the east where the Indian Ocean, the Persian Golf, etc. always formed a barrier to the direct expansion of freshwater animals. Relics of the tropical invaders from India into the Anatolian freshwater fauna are rare today. This is easily understood from the fact that at the end of the Tertiary three main factors contributed to a destruction of biotopes suitable for their existence: (1) The climate changes in the Glacial Age, (2) the desiccation of most of the central Anatolian lakes or their transformation into azoic salt lakes, (3) the elevation of the Anatolian plains to more than 1000 metres above sea level, which resulted in very hard winters. But there are some sufficiently warm refuges, as, for instance, the lakes from which the Great Meander rises, where such interesting forms still persist and now live together with other species which are of a totally different origin. In the sources of the Great Meander, swarms of new species of *Mesomysis*[2] live together with fish of Indian, central European, and south European relationship. The Crustacean mentioned above belongs to a genus, the distribution of which was hitherto thought to be restricted to the basins formed by the separation of the Sarmatian Sea. This greatest inland sea of brackish to freshwater character of the second half of the Tertiary persists today in the form of three basins separated from one another: the Black Sea, the Caspian Sea, and lake Aral. The influence of the Sarmatian fauna on that of Anatolia was very important for relatively long periods[1]. On one side the north Anatolian coast was bordered by the Sarmatian Sea, or, that is, the two parts here concerned: the Euxine and the Dacian lakes. The former was saltier than the latter, and both were separated from one another by the Crimean land between the Podolian platform and Cape Bafra. As far as we can judge, the Dacian Lake was important for the faunal exchange between central Europe and Anatolia. The Sarmatian Sea was joined to the Aegean lake system, which covered the territory of the modern Aegean Sea and ended in the Mediterranean near the island of Cos. The influence of central European species on the rivers Maritza, Struma, and Vardar, and in the territory of Greece and western Asia Minor can easily be understood from this geographical state of affairs. This situation explains also the route followed by freshwater fishes of south European origin from Greece to Anatolia. A system of rivers and lakes in the lowlands of the Aegean land mass favoured the exchange of faunal and freshwater groups of animals. On the other hand, even in Tertiary or Quaternary times the Aegean lake system was a faunal barrier for animals of other ecological requirements than those of freshwater animals. For instance, the petraëic millipedes are quite different on the Asiatic and European sides of the Aegean Sea. The difference is certainly the result of a long period of isolation of the two sides by a territory, the ecological make-up of which was an impassable boundary for them.

After the breakdown of the Aegean continent in glacial times, the faunal exchange between Greece and Asia Minor ceased. By the newly formed Aegean Sea many species extended northwards from the Mediterranean into the Sea of Marmara and the Black Sea, which were at this time separated from the Caspian; here the old Sarmatian fauna of brackish or fresh water could persist up to our days, whereas in the Black Sea this Sarmatian element was partly destroyed and partly driven into the deltas of its great rivers or into lakes separated from the basin of the Black Sea itself. More than 75% of the fish species of the Black Sea of today are of Mediterranean origin[2]. A large number of forms return for spawning into the Sea of Marmara or even into the Mediterranean after having visited the rich feeding grounds of the Black Sea. The economic importance of the Bosphorus depends essentially upon the intensive fishing provided by the regularly migrating species, such as mackerel, bonito, and others.

Besides the tropical forms of Indian origin in the Anatolian fauna of freshwater fish, there is one other group of fishes which is completely lacking in Europe. For this the Cyprinid genera *Acanthorutilus* (Anatolia and Mongolia), *Varicorhinus* (Anatolia, Transcaucasia,

[1] C. Kosswig, 1950 (in the press).
[2] M. Bacescu, Revista Sciintifica «V. Adamachi» *34*, 1 (1948).

[1] C. Kosswig, C. r. Soc. Turque Sci. nat. *9*, 37 (1942). – C. Kosswig and F. Battalgil, Rev. Fac. Sci. Univ. Istanbul [B] *7*, 145 (1942).
[2] E. Slasdenenko, Ann. Sci. Univ. Jassy *22*, 280 (1936).

Syria, Palestine, north Africa), *Acanthobrama* (western Anatolia to Palestine, its nearest relative *Capoëtobrama* in the Amu Daria and Syr Daria in central Asia) can be named. The Bosphorus is, from the geological point of view, a very recent formation; nevertheless it is an absolute barrier to the westerly distribution of all these Asiatic forms. The rich representation of some of these genera in Asia Minor and the distribution of some of their species over many river systems of Anatolia favours the assumption that the relative age of these forms is very great. If this statement is correct, the original western frontier of all these species cannot have been the Bosphorus and the Aegean Sea, only formed, as seen above, during the Quaternary. It is more probable that these forms, which are richly represented in the mountainous regions of western and central Asia, entered Anatolia so early that they could make full use of the way southward into Palestine and even into Africa. This way is known as the Pliocene land-bridge in the Syrian-Iranian area. If this hypothesis is true, the Bosphorus and the Aegean Sea could not play the decisive role in the separation of these Asiatic genera from Europe. The frontier of these Asiatic elements in Anatolia was likely more the western Anatolian mountain system, by which the Aegean zone is separated from the plains of central Anatolia. It is a well known fact that the upper beds of the different rivers on the Aegean slope of the west Anatolian mountains retained only secondary relationship with the central Anatolian high plateau and the remnants of the lake system which once covered it. The overground connection of these lakes is even now only partially existent, many lakes send their waters by underground ways through the mountains to the rivers on the Mediterranean or the Aegean slopes of south and west Anatolia.

Similarly, in the south and in the north, high mountains separated the central Anatolian lake from the Mediterranean as well as from the Black Sea (i. e. the Sarmatian coast). From the east, on the other hand, the entrance into central Anatolia was more or less open and facilitated by the upper reaches of the eastern Anatolian rivers, which flow from east to west. The union of the Aegean coast with central Anatolia by the modern river systems was definitely effected after the Aegean continent broke down. As the Asiatic forms came too late, they found no freshwater ways by which to pass to the European side of the Aegean Sea.

Now we have to return to the problems concerning the Anatolian steppes. As stated above, the altitude of Anatolia was reached only in the course of the second half of the Tertiary or even later. Salomon-Calvi[1] dates the rise of Anatolia as late as in the Quaternary, supposing that the two phenomena, the Aegean subsidence and the elevation of Anatolia, were the expression of the same movement in the crust of our region. The Tertiary climate in the interior of Anatolia was warmer and wetter than today. In the Quaternary the humidity increased. As the result the surface of the lakes which persisted till today as brackish water, like the lake of Burdur, at that time stood 90 metres higher[1]. Remnants of old lake terraces with clearly visible traces of the eroding waves surround the Great Salt Lake; the lake of Van is only a small relic of a greater inland sea, covering not only the territory of the lake of Van but also that of the plains of Mush. The majority of the central Anatolian lakes were in connection with one another[2]. A rich vegetation surrounded this watered panorama of glacial Anatolia.

Recent research has shown that the natural lower boundary of forests of a more or less dry type lies so deep that even in our days the whole area from the west of Malatya to Bitlis must be included in the forest zone and does not belong to the steppe facies[3]. Natural steppes are found in central Anatolia, in the high plateaux around Mount Ararat, and in the south of the eastern Toros, in the area which forms the continuation of the warmer Syrian steppes towards the north. The fauna of these eremial regions is derived to a great extent from forms which in earlier times inhabited the arboreal, but still exist in the same regions which underwent steppification later. The Anatolian butterflies and moths have, for example, systematic relationship mostly with the central European and Mediterranean fauna, but not with that of central Asia, where, since a very long period, the eremial facies is characteristic. Amongst the mammals of Anatolia, especially in the rodents, the percentage of steppicolous species is greater than in most other orders. *Spalax, Spermophilus, Alactaga, Cricetulus* may be mentioned here. In the reptilia the number of typical eremial genera is high only in the eastern steppe zone, i. e. the Ararat plateau. Here *Phrynocephalus, Eremias,* and *Eumeces* represent the real eremial fauna. Only one species, *Eumeces schneideri*, has been found once in the steppes in the centre, which have been well investigated, near Ankara. In this latter region, besides the euryoecius *Ophiops elegans*, a species of *Lacerta, Lacerta parva,* derived from the arboreal, has adapted itself to the conditions of life in the steppe. The same is true for the remarkable, rare, and primitive *Lacerta princeps* in the Ararat highlands.

Even in a short review of only some problems of historical zoogeography in the Near East, the marine fauna with its changing scenery cannot be neglected. In the beginning of the Tertiary, the Tethys Sea covered large areas which today are dry land. From the West Indies to the Pacific Ocean a rich community of tropical animals populated the litoral zone of this sea, surrounded

[1] W. Salomon-Calvi, Rev. Fac. Sci. Univ. Istanbul *4*, 23 (1939).

[1] H. Louis, Z. ges. Erdkunde Berlin *1938*, H. 7 und 8.

[2] E. Lahn, Publ. Inst. Etudes et recherches minières en Turquie (1948).

[3] H. Louis, Geograph. Abh., 3. Reihe, fasc. 12 (1939).

by coral reefs. In the second half of the Tertiary great changes occured in that part of the Tethys which was finally to be transformed into the Mediterranean of today. Land-bridges rose, cutting off the continuity of the sea. The loss of communication with the Indo-Pacific has lasted until our days. The rich fossil bearing beds of the Lebanon and of Monte Bolca in Italy give us information about the great number of tropical genera in the Mediterranean of that time, while now they are confined to the Indian and Pacific Oceans. EKMAN[1] found general agreement for his thesis that the extinction of the tropical fauna of the Tethys in the Mediterranean was the result of the fall in temperature in late Tertiary and Quaternary times. In the modern fauna of the Mediterranean, again, tropical forms play the decisive role, but these forms are related mainly to the fauna of the warmer parts of the Atlantic Ocean. Besides these, species with boreal relationship can be found too. It is probable that they entered the Mediterranean in the near past, when, as a result of the cooling of the Atlantic to lower latitudes, the boreal area extended further to the south. Some of the boreal invaders of that time persisted in the Mediterranean in the post-glacial period, mixing with aggressive and euryoecious species of tropical and subtropical distribution in the Atlantic. It is still not exactly known whether the majority of these species persisted in the Mediterranean itself in the period of its separation into different parts and its cooling at the same time, or whether they later reoccupied this sea. The ecological efficiency of these species is clearly demonstrated by the fact that they freely entered the much colder Black Sea, definitely establishing themselves there. As a result of the rhythmic transgressions of warmer Atlantic waters to the north, real equatorial species of this ocean appear from time to time on the English coast and more frequently in the Mediterranean, especially in its western parts and on the Algerian coast. But such forms apparently are not sufficiently adapted to the conditions in the Mediterranean. Some which persisted remain rare, others died out after short periods. It is not certain whether for this phenomenon the physical or the biological conditions are decisive. For instance the earlier occupation of all ecological niches by well adapted species could have prevented the successful establishment of these late invaders from the equatorial regions of the Atlantic. Information, for which we are indebted in the first place to Dr. W. STEINITZ, is enough to contradict this view[2]. Since the opening of the Suez Canal in 1869 an invasion into the Mediterranean of species of the Indo-Westpacific fauna has begun. These species coming from the Red Sea, the warmest and saltiest sea we know, passed through the Suez Canal with its changing and extreme ecological conditions probably in the course of some generations and safely reached the Mediterranean. Ten species, which have expanded by the aid of the northward current in the eastern Mediterranean, were recorded by W. STEINITZ for Haifa in 1927. Another ten were added to this list twenty years later by G. HAAS and H. STEINITZ[1]. Ten species at least, partly different from those known from Haifa, can be found in Alexandretta, three of them are known from Rhodes at the entrance to the Aegean Sea, since 1943. All these facts indicate that these tropical Indo-Pacific forms, with very different biological requirements, have found a great variety of ecological niches suitable for them. The degree of plasticity which these Erythraean fish, Crustacea, bivalves, sea-urchins and others show, is remarkable and not in harmony with EKMAN's supposition that the ancestors of these new invaders died out in the Mediterranean at the end of the Tertiary as a result of the cessation of the limited environment in a tropical coral sea. This invasion of Erythraean species into the Mediterranean is the more remarkable as reversed infiltration of Mediterranean forms into the Red Sea was very limited. It corresponds in an interesting way to the ingress of Mediterranean species into the Black Sea, also against the gradient of temperature and salinity. Here zoogeographical phenomena touch problems of genetics and evolution, the discussion of which is outside the scope of this lecture.

As stated above, it is not clear to what degree modern Mediterranean species have persisted in the second half of the Tertiary and in the Quaternary. H. STEINITZ[2] is inclined to suppose that the modern Mediterranean blennies are relics *in loco* of the Tethys in our region. But it must be kept in mind that, like most marine animals, blennies have pelagic larvae, which by passive locomotion could re-occupy an area lost in the past. On the other hand there are in fact relics of the old fauna of the Tethys even in places where they would be least expected to survive: in fresh and brackish waters of the Anatolian plateau, as well as in similar biotopes in the neighbourhood around the Mediterranean nearly at sealevel. I should like to draw your attention to a small family of fish, the Cyprinodontids. The genera *Cyprinodon* and *Aphanius* consist of some species in central and southern North America, and others around the Mediterranean and in central Anatolia, in the Dead Sea region, and finally in the western part of the Indian Ocean, including the Red Sea. Apparently this distribution as a whole corresponds to the western part of the Tethys. Everywhere these small fish live in such biotopes as marine coastal waters, the mouths of rivers, in lakes in the neighbourhood of the sea, in fresh and salt springs inland, swimming freely in waters of very different salt concentration. As stated above, Anatolia, nearly at sealevel in earlier geological

[1] S. EKMAN, *Marine Tiergeographie* (Akademische Verlags-Ges., Leipzig 1935).

[2] W. STEINITZ, Publ. Staz. Zool. Napoli *8*, 312 (1927); Int. Rev. Ges. Hydrogr. *22*, 1 (1929).

[1] G. HAAS and H. STEINITZ, Nature *160* 28 (1947).

[2] H. STEINITZ, Rev. Fac. Sci. Univ. Istanbul [B] *14*, 121 (1949).

periods, was elevated later. Cyprinodontids, having migrated more towards the inland, were thrust up with the rising Anatolian land mass. On account of their great euryhalinity, they were able to survive in many places and form today one of the most characteristic groups in Anatolia and also in Palestine.

It is probable, that other survivers[1] of the Tethys are to be found among some of the subterranean genera of invertebrates around the Mediterranean and in Central America, including relatives of many marine forms of today. Such genera as *Caecosphaeroma, Monolistra,* and others may be mentioned. The transition of the ancestors of these cavernicolous forms to life in darkness was most probably accomplished by adaptation to specialized conditions of life in dark, cave-like places in the sea. Later, by the elevation of such formations rich in limestone, these forms became members of the subterranean inland fauna, without having passed through a stage of phylogenetic development in the superficial fresh-waters of the continents.

[1] C. Kosswig, C. r. Soc. Turque Sci. nat. *10*, 31 (1943). – H. Lohmander, Verh. naturf. Ges. Basel *50*, 126 (1939).

Zusammenfassung

In der Landfauna Anatoliens können Beziehungen zu folgenden benachbarten oder weiter entfernten Gebieten deutlich festgestellt werden:

1. Es gibt Elemente in der anatolischen Fauna, die sich wahrscheinlich schon in prätertiären Zeiten verbreitet haben und die zum Teil deutliche gondwanische Beziehungen haben.
2. Relikte gehören vielfach zur paläarktischen Fauna des Tertiärs.
3. Im Lauf des Quartärs erschienen neue Einwanderer.
4. Postglaziale Einwanderer sind indischen oder afrikanischen Ursprungs und kamen über Syrien–Palästina.
5. Offenbar ebenfalls postglaziale Einwanderer entstammen dem asiatischen Eremial.

In der Süßwasserfauna Anatoliens, besonders bei Fischen und Krustazeen, können unterschieden werden:

1. Alte endemische Formen mit Beziehungen zur perimediterranen Süßwasserfauna.
2. Sarmatische Formen, welche mit Hilfe dieses Binnenmeeres zugleich Mitteleuropa mit Anatolien verbinden.
3. Einwanderer, wahrscheinlich im Lauf des Pliozäns, sowohl von Indien als auch von Zentralasien her.

In der marinen Fauna ist besonders das Vordringen von erythräischen Arten im östlichen Mittelmeer bemerkenswert, welche durch den Suezkanal ins Mittelmeer eindrangen.

Die Sexualduftstoffe an Lepidopteren

Von Bruno Götz[1], Freiburg i. Br.

Das Zusammenfinden der Geschlechter zum Zwecke der Paarung kann bei Insekten auf verschiedene Weise gesichert werden. Bei manchen spielen akustische Reize eine Rolle (zum Beispiel bei den Saltatorien), bei anderen optische (zum Beispiel bei manchen Ephemeriden und Dipteren). In der Mehrzahl sind es aber doch wohl Geruchsreize, welche die Geschlechtspartner zusammenführen.

Kenntnisse über die *Sexualduftstoffe,* über ihre Wirkung, über die Drüsen, von denen sie ausgeschieden werden, besitzen wir leider nur von den Lepidopteren, obwohl ihnen sicherlich auch bei anderen Insekten eine größere Bedeutung zukommt.

Duftorgane sind bei Lepidopteren sowohl dem männlichen wie weiblichen Geschlecht eigen. Ihr Zweck ist jedoch verschieden. In der Regel fällt dem Männchen die Aufgabe zu, die Weibchen aufzusuchen. Besondere Duftdrüsen der letzteren scheiden daher einen Sexualduftstoff aus, den die männlichen Individuen schon aus mehr oder weniger großer Entfernung wahrnehmen und dessen anlockender Wirkung sie sich nicht entziehen können. Die Sekrete der männlichen Duftorgane dagegen erhöhen die Bereitwilligkeit der aufgefundenen Weibchen zur Kopulation. Sie sind also Reiz- und keine Lockmittel.

[1] Versuchs- und Forschungsanstalt für Weinbau und Weinbehandlung, Zoologische Abteilung, Freiburg i. Br.

I. *Die Sexualduftdrüsen*

Alle rein weiblichen Duftorgane von Schmetterlingen, die anlockende Sexualduftstoffe ausscheiden, finden sich am hinteren Ende des Abdomens.

Die abdominalen Duftorgane der Weibchen sind aus einer Intersegmentalfalte entstanden, und zwar gewöhnlich der zwischen dem 8. und 9. Abdominalsegment gelegenen. Histologisch gleichen sich diese Duftorgane insofern alle, als die Membranhypodermis sich zu einem mehr oder weniger stark entwickelten Drüsenepithel umgewandelt hat. Das Plasma in der Zelle ist gewöhnlich von zahlreichen kleinen und großen Vakuolen durchsetzt, wodurch es eine weitmaschige Struktur erhält. Der Zellkern ist meistens stark vergrößert. Seine Gestalt variiert bei den einzelnen Arten. Zwischen den Vakuolen und dem Zellkern scheinen irgendwelche Beziehungen zu bestehen, die bei starker sekretorischer