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Studies on *Desmopterus* CHUN 1889 Species in the Indian Ocean*

by

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With 8 figures in the text

Studien über die Arten von *Desmopterus* CHUN 1889 im Indischen Ozean

Zusammenfassung

Die Gattung *Desmopterus* (Pseudothecosomata, Gastropoda) besitzt zwei Arten. Es handelt sich um *D. papilio* CHUN 1889 und *D. gardineri* TESCH 1910. Beide Arten sind tropisch und haben eine weite Verbreitung zwischen 40° N und 40° S. *D. papilio* tritt häufig auf, während *D. gardineri* sehr selten ist. Die vorliegenden Untersuchungen am Zooplanktonmaterial der Internationalen-Indischen-Ozean-Expedition (IIOE) zeigen, daß *D. papilio* häufig ist im Gebiet der Somali-Küste, im Golf von Aden, an der südarabischen Küste, im Golf von Oman, an der Westküste von Pakistan, an der Südwestküste von Indien, im nördlichen und westlichen Golf von Bengalen, in der südlichen Andamanen-See und im Nordwesten von Australien. Die größte Häufigkeit wurde im Gebiet vor Cochin beobachtet. *D. gardineri* ist relativ häufig im Golf von Bengalen, in der Äquatorialzone und im Nordwesten von Australien. Die jahreszeitlichen Schwankungen der Häufigkeit zeigen, daß *D. papilio* stärker während der Periode auftritt, die vom Nordostmonsum im nördlichen Indischen Ozean beherrscht wird. Entlang 110° E wurden zwei Maxima festgestellt, eines von April bis August zwischen 9° und 11° S und ein anderes von November bis Februar zwischen 17° und 23° S. *D. gardineri* wird vor allem zwischen April und August beobachtet. Die Verteilung in Bezug zur Temperatursprungschicht zeigt, daß *D. papilio* beinahe gleichmäßig oberhalb und unterhalb der Temperatursprungschicht während des Tages und der Nacht auftritt. Dagegen fehlt *D. gardineri* beinahe vollständig oberhalb der Temperatursprungschicht. Daher scheint die Temperatursprungschicht eine Barriere für die Verteilung von *D. gardineri* zu sein.

Summary

The genus *Desmopterus* (Pseudothecosomata, Gastropoda) includes two species. They are *D. papilio* CHUN 1889 and *D. gardineri* TESCH 1910. Both are tropical species having widespread distribution between 40° N and 40° S. *D. papilio* is common in occurrence, but *D. gardineri* is very rare. The present study on zooplankton collections of the International Indian Ocean Expedition (IIOE) reveals that *D. papilio* is abundant in the area off the Somali coast, Gulf of Aden, South Arabian coast, Gulf of Oman, West coast of Pakistan, South-West coast of India, northern and western Bay of Bengal, southern Andaman Sea and North-West Australian Sea. The highest abundance was noticed in the area off Cochin. *D. gardineri* is relatively common in the Bay of Bengal, equatorial zone and North-West Australian Sea. The seasonal variation in spatial abundance shows that *D. papilio* is distinctly more abundant during the period dominated by the North-East Monsoon in the North Indian Ocean. Along 110° E two maxima were found, one during April—August between 9° and 11° S and another during November—February between 17° and 23° S. *D. gardineri* occurs mainly between April and August. The distribution in relation to the thermocline shows that *D. papilio* is almost uniformly abundant above and below the thermocline during day and night. But *D. gardineri* was almost absent above the thermocline. Therefore the thermocline appears to be a barrier for the distribution of *D. gardineri*.

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Introduction

The genus *Desmopterus* was created by CHUN in 1889 to include a single species *D. papilio*. Later on TESCH (1910) added a new species *D. gardineri* with a single specimen collected near Chagos Archipelago. This genus is treated as one of the aberrant genera of the family Cymbulidae under Pseudothecosomata (TESCH 1946). MEISENHEIMER (1905) treats it as a separate family (Desmopteridae) under Pseudothecosomata. MCGOWAN (1968) includes it as a separate order under Gymnosomata because of the absence of either calcareous shell or pseudoconch. However the simple radula with three rows of longitudinal teeth, large swimming plate and the presence of calcareous external shell in the embryonic stage (TESCH 1904) justify the systematic position of this genus under Pseudothecosomata. The peculiar feature of this genus is that the concha is totally absent in both of its species in the juvenile and adult stage. The total absence of gizzard and the fusion of stomach and liver into large sac (MEISENHEIMER 1905) are probably some of the features in the evolutionary step of this genus towards Gymnosomata. The descriptions of *D. papilio* and *D. gardineri* are given by TESCH (1910 and 1946) and figures by FRONTIER (1963 Fig. 1, 2, 3 and 4). The difference between the two species falls mainly on the musculature of fins. The musculature is formed of broad bands and distinctly separated in *D. gardineri* whereas in *D. papilio* it is very narrow and indistinctly separated from one another. Otherwise both species have the same morphological character. Two long tendril-like tentacles were observed in *D. papilio* in a few collections of "Zulfiquar" along the coast of West Pakistan, which were normally found to be highly fragile and broken off in other collections. A large number of juveniles were found in both species.

D. papilio has been reported from the Mediterranean, Pacific, Atlantic and Indian Ocean. FRONTIER (1963) has noticed the abundant occurrence of this species in the Gulf of Aden and Gulf of Oman. But *D. gardineri* is seldom reported. Except a single record in the Florida current (WORMELLE 1962) *D. gardineri* has not been so far reported in the Atlantic and Pacific. In the Indian Ocean however, after TESCH's single record in 1910, FRONTIER (1963) reported the occurrence of this species from nine stations in the northern Arabian Sea followed by SAKTHIVEL (1965) from 32 stations in the Bay of Bengal and western half of the Indian Ocean. Otherwise the distribution and relative abundance of these species, their seasonal and diurnal variations were not known.

The present study was carried out on the sorted fractions of Thecosomata of 1927 IIOE zooplankton collections and 180 collections of the Seasonal Biological Cruises of the Division of Fisheries and

Oceanography, CSIRO, Australia. The station list and other sampling details of the IIOE collections were published by IOBC (1969) and the Seasonal Biological Cruises by CSIRO Australia (CSIRO Aust. 1965a, 1965b, 1965c, 1965d, 1966a and 1966b). Most of the collections were made from the depth of 200 m to the surface by the Indian Ocean Standard Net (CURRIE 1963). The numerical data collected for each species of the genus *Desmopterus* are presented here in the form of distribution charts and figures. As the geographical coverage of the stations were not enough to split more than two seasons, the entire year was broadly divided into April 16th—October 15th as one and October 16th—April 15th as another season. The above seasonal grouping covers the period of South-West and North-East Monsoons in the North Indian Ocean. Apart from this broad seasonal study for the entire Indian Ocean a special study was made from the six regular Seasonal Biological Cruises along the meridian 110° E. On each of the six cruises, 16 stations were worked at 90 miles (1.5°) intervals along the cruise track (Fig. 1C). On each day two stations were worked out, one in the morning (between 0800—1200 hrs) and the other in the evening (between 2000—2400 hrs). Therefore the entire track was covered with one set of day collections and another set of night collections. The data collected from these collections were used for latitudinal, seasonal and diurnal variations.

The next section deals with annual variations along 78° E. During the IIOE "Umitakamaru" and "Kagoshima Maru" have cruised the meridian 78° E twice, the first cruise during December 1962—January 1963 and the second cruise during December 1963—January 1964 of the same duration (Fig. 1B). Twenty to twentythree collections have been made between 8° N and 25° S in the dark hours. The number of organisms collected during the first year was compared with the second year.

The last section deals with the distribution in relation to the thermocline. During the IIOE R.R.S. "Discovery" has collected a set of 62 + 62 zooplankton samples in the western half of the Indian Ocean (Fig. 1A). From each station two collections have been made: one from 200—0 m and the other from the top level of the thermocline to the surface. The number of organisms collected from the short haul (thermocline—0 m haul) was subtracted from the numbers of the long haul (200 m—0 m) to estimate the number below the thermocline. The depth of the thermocline was varying from 30 m to 120 m. The non-random distribution of organisms do not permit to calculate the number of organisms in terms of per m³ from the above two types of hauls (SAKTHIVEL in press). The day and night stations were separated to elucidate diurnal variation.

Results

The geographical distribution and relative abundance

D. papilio was found to be one of the common species of Thecosomata in the IIOE collections. In the order of occurrence and abundance this species attains the first rank in Pseudothecosomata. Out of the total collections examined, this species was present in 810 samples, of which 442 were in day and 368 in night. The average number of organisms during day was 22 and during night 26. From the distribution it appears that *D. papilio* has almost uniform distribution in day and night in the upper 200 m. In the Florida current WORMELLE (1962) too has observed the day and night distribution in between 50 and 300 m. *D. papilio* is in general less common in the oceanic province and reaches its peak abundance in the coastal waters. Beyond 30° S this species was rarely found.

Distribution during April 16th—October 15th (Fig. 2) shows that *D. papilio* is more common in the Mozambique channel, South Arabian Coast, Bay of Bengal, equatorial zone and West Australian Sea. The area of abundance (10 to 100/haul) is seen along the South Arabian Coast, Western Bay of Bengal, Andaman Sea and isolated areas in the equatorial zone. The greater abundance is noticed in the form of patches in the coastal waters of the South Arabia and Malacca Strait. But the distribution during October 16th—April 15th (Fig. 3) is more widespread and the area of abundance is seen north-east of Madagascar, Somali Coast, Red Sea, Gulf of Oman, West Coast of India and Pakistan, around Ceylon, Western Bay of Bengal, Southern Andaman Sea and isolated areas in the West Australian Sea. The greater abundance is found in between Goa and Cochin, Gulf of Oman and near Socotra Island. The highest abundance (1000 to 3365/haul) is noticed in three stations off Cochin in dusk and dawn hours. From the above distribution it appears that season has high influence on the abundant occurrence of this species. The distinct difference in the spatial abundance between the above two seasons suggests that the breeding and spawning period of *D. papilio* falls mainly between October and April in the North Indian Ocean.

D. gardineri is more than four times less common in occurrence than its counterpart *D. papilio*. This species was present only in 196 collections out of which 106 were in day and 90 in night. The average number of organisms per haul was four and the highest number per catch was 33. This species seems to be more common in the Bay of Bengal, equatorial zone (10° N—10° S) and the West Australian Sea (Fig. 4). Beyond 30° S this species was found to be very rare. Two major areas of abundance were

noticed, one off the South Arabian Coast and the other in the Western Bay of Bengal.

Seasonal variation along 110° E shows that *D. papilio* is more common between February and August and rare during the rest of the period (Fig. 5). Two maxima were found, one between April and August in the northern latitudes (9°—11° S) and the other between November and February in the central latitudes (17°—23° S). As a whole this species is of common occurrence in the central and northern latitudes and rare south of 29° S. The maximum number of records were found in the month of February and April. The diurnal variation of this species is not very pronounced. As the percentage of occurrence is higher during the day (47%) than during the night (40%) it appears that this species is positively phototactic.

Out of 180 collections *D. gardineri* was found only in 13 collections and 10 of them between April and August (Fig. 6). The highest number (13/haul) was found at one night station at 11° S in May. This species seems to be more common in the northern part of the section (north of 20° S).

Annual variation along 78° E shows that *D. papilio* was found only in five stations during the first year (Dec. 1962—Jan. 1963). Three of them were situated between the equator and 4° N. The central and southern latitudes show only two records. During the second year (Dec. 1963—Jan. 1964) *D. papilio* was present in 13 stations out of which six were between 7° N and the equator and another six between 14° S and 23° S. The numerical abundance was highest north of Equator. The reason for the poor occurrence in the first year and common occurrence in the second year is not clearly known. The central latitudes between the equator and 15° S are very poor in both years.

D. gardineri was not at all encountered during the first year. During the second year it was found on four stations. All of them are situated between 5° N and 5° S. On the whole the environmental conditions in the second year seem to be more favourable for the *Desmopterus* species.

Distribution in relation to the thermocline

D. papilio appears to have been uniformly distributed above and below the thermocline in the upper 200 m during day and night (Fig. 7). Therefore the thermocline does not seem to be a barrier for the distribution of this species. The occurrence of this species during day was 63% and during night 52%. The average number of organisms above and below the thermocline was varying from four to six. Only three stations (Fig. 1A, St. 5262, 5406, 5446) contained 20 to 23 individuals per haul. On track F (Fig. 1A) the catches of the species were very low.

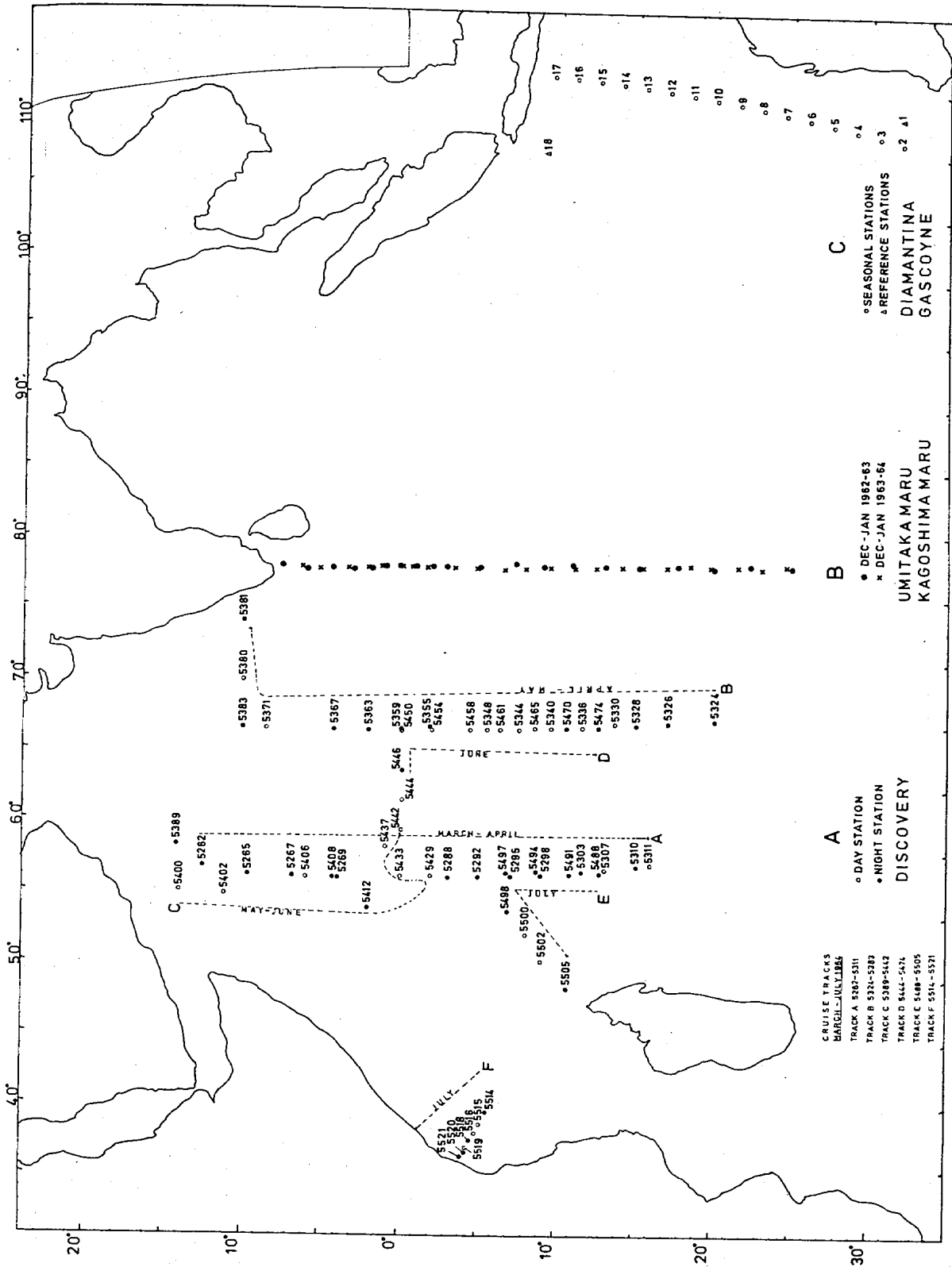


Fig. 1. Map showing the stations for special studies.
 A. For distribution in relation to thermocline.
 B. For annual variation along 78° E.
 C. For seasonal variation along 110° E.

Abb. 1. Stationskarte. A. für die Verteilung in Beziehung zur Temperatursprungschicht. B. für die jährlichen Schwankungen entlang 78° E. C. für die jahreszeitlichen Schwankungen entlang 110° E.

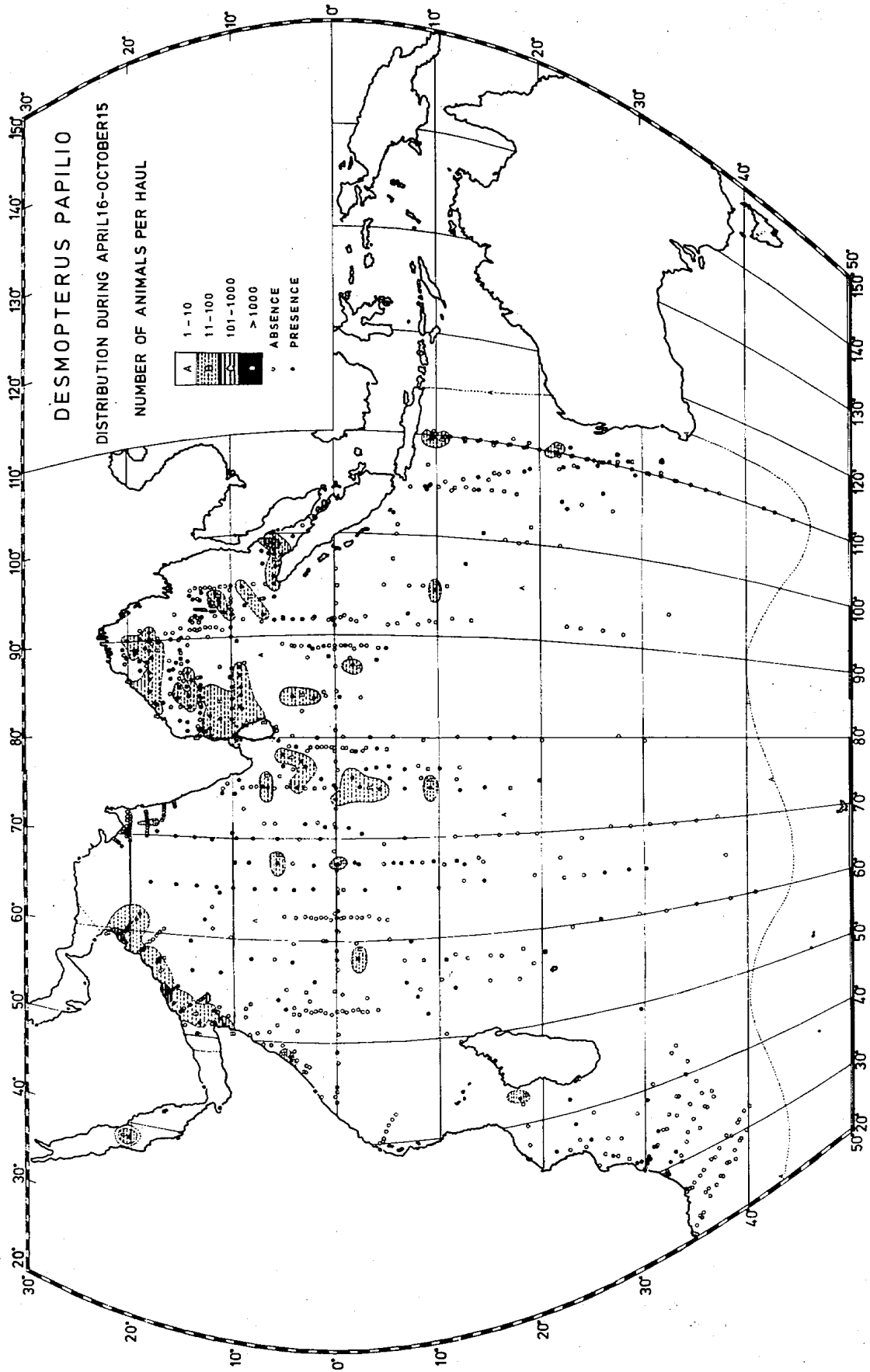


Abb. 2. Verteilung von *Desmopterus papilio* vom 16. April bis 15. Oktober.

Fig. 2. Distribution of *Desmopterus papilio* during April 16th—October 15th.

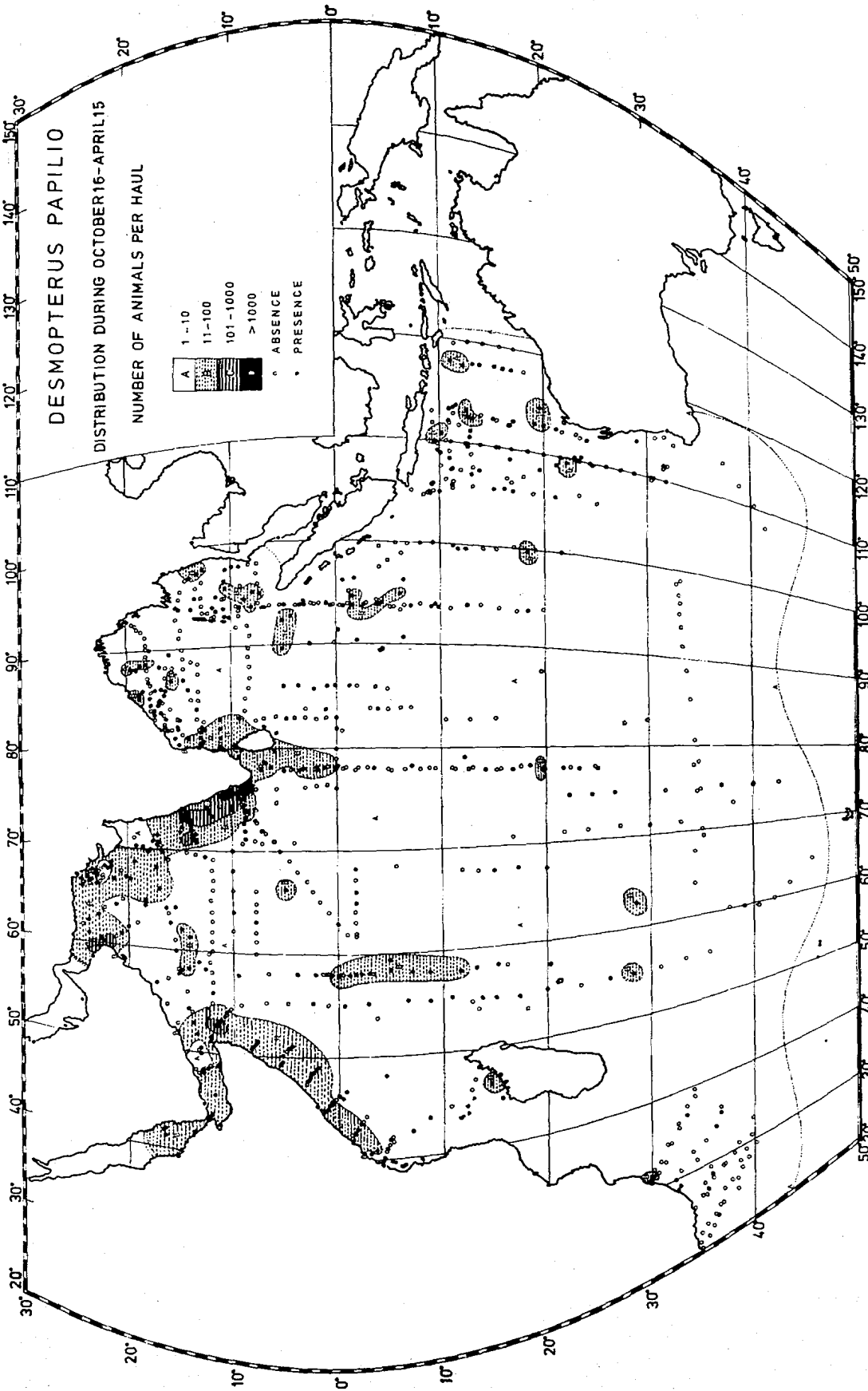


Abb. 3. Verteilung von *Desmopterus papilio* vom 16. Oktober bis 15. April.

Fig. 3. Distribution of *Desmopterus papilio* during October 16th—April 15th.

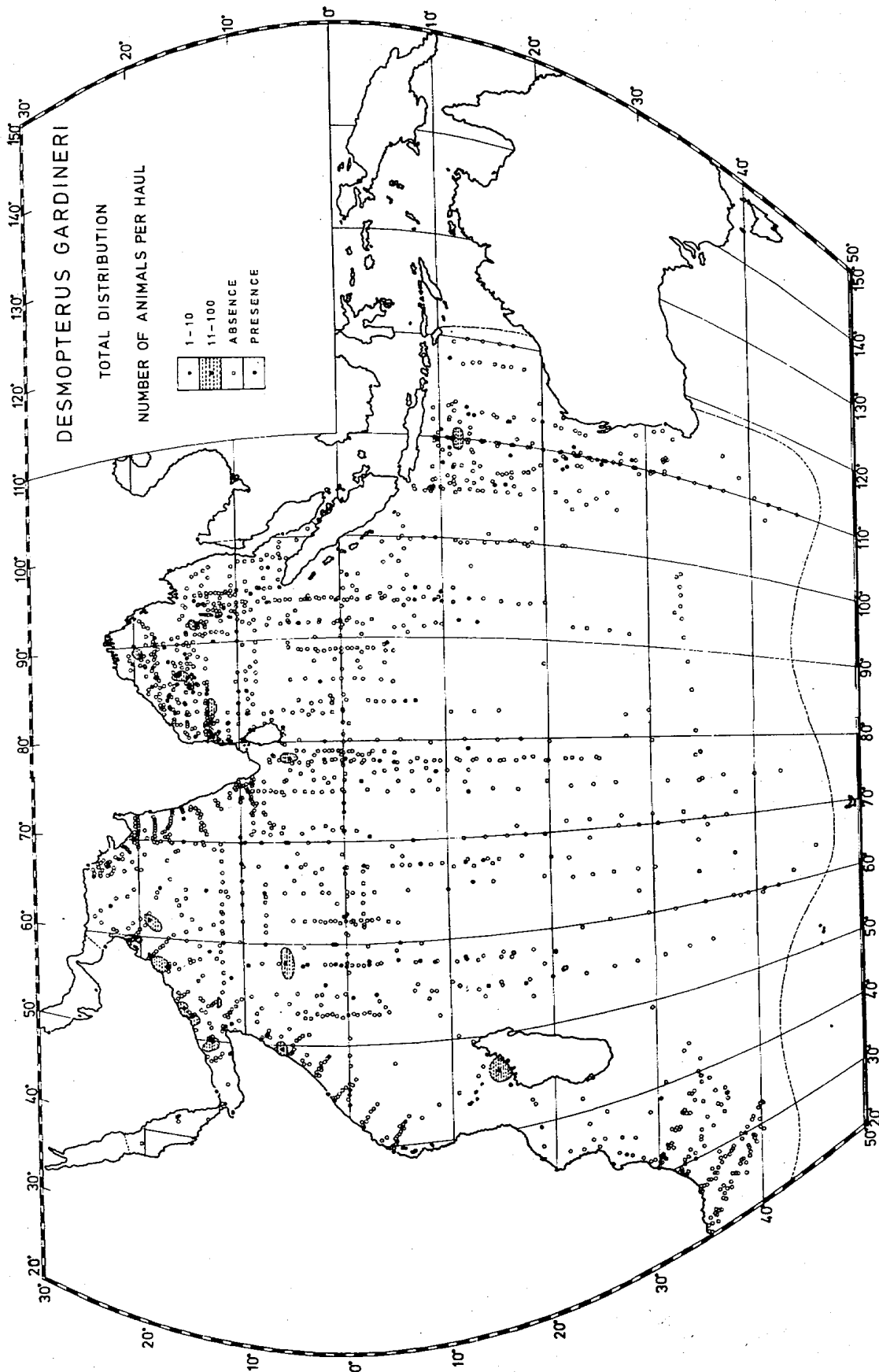


Abb. 4. Verteilung von *Desmopterus gardineri*.

Fig. 4. Distribution of *Desmopterus gardineri*.

DESMOPTERUS PAPILIO

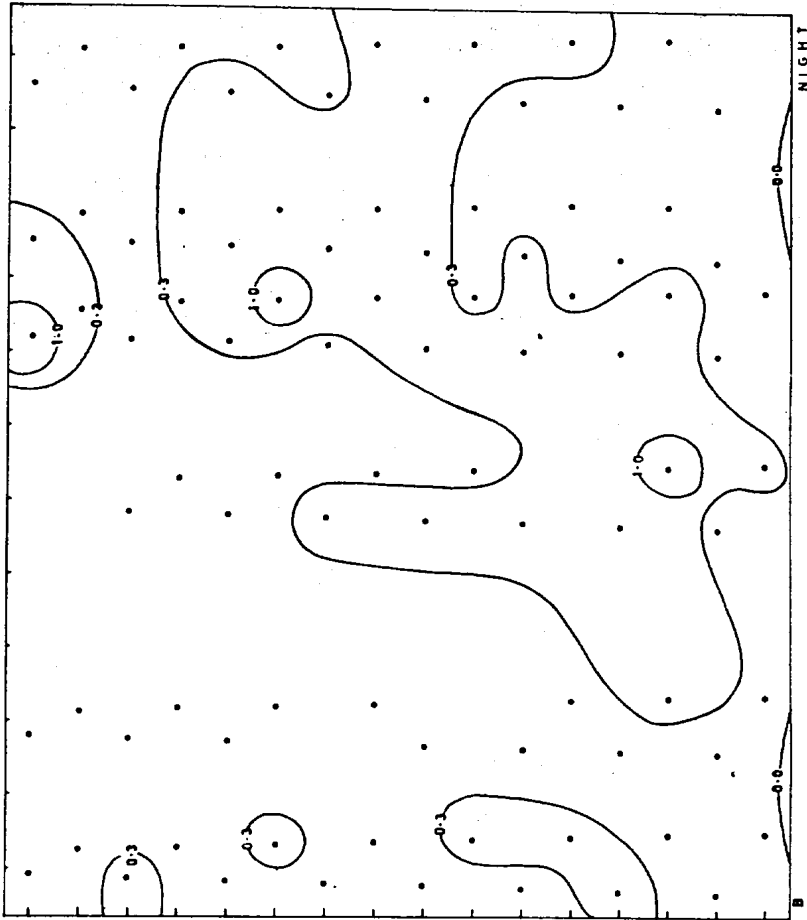
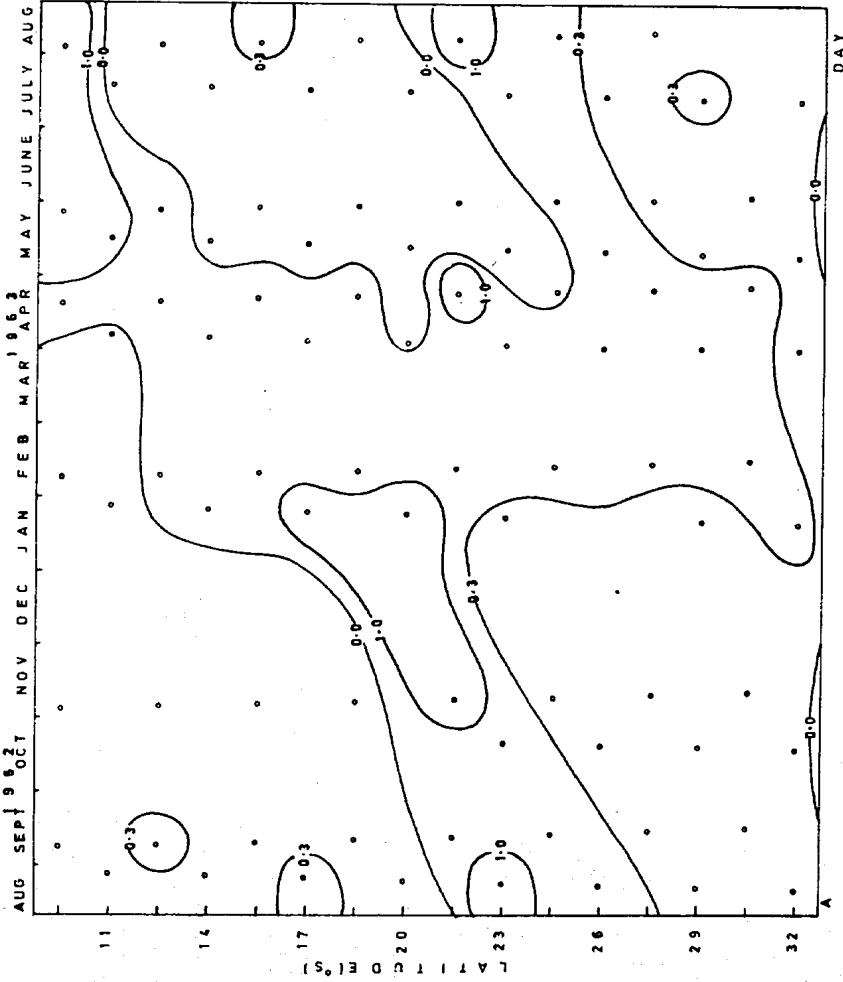


Fig. 5. Latitudinal diurnal and seasonal variations of *Desmopterus papilio* along 110° E.
 A. Day, B. Night, Contours Log 10 (No/200 m³).

Abb. 5. Tag-Nacht-Verteilung und jahreszeitliche Verteilung von *Desmopterus papilio* nach der geographischen Breite entlang 110 °E. A. Tag, B. Nacht. Isolinien: 1 g (Zahl/200 m³).

DESMOPTERUS GARDINERI

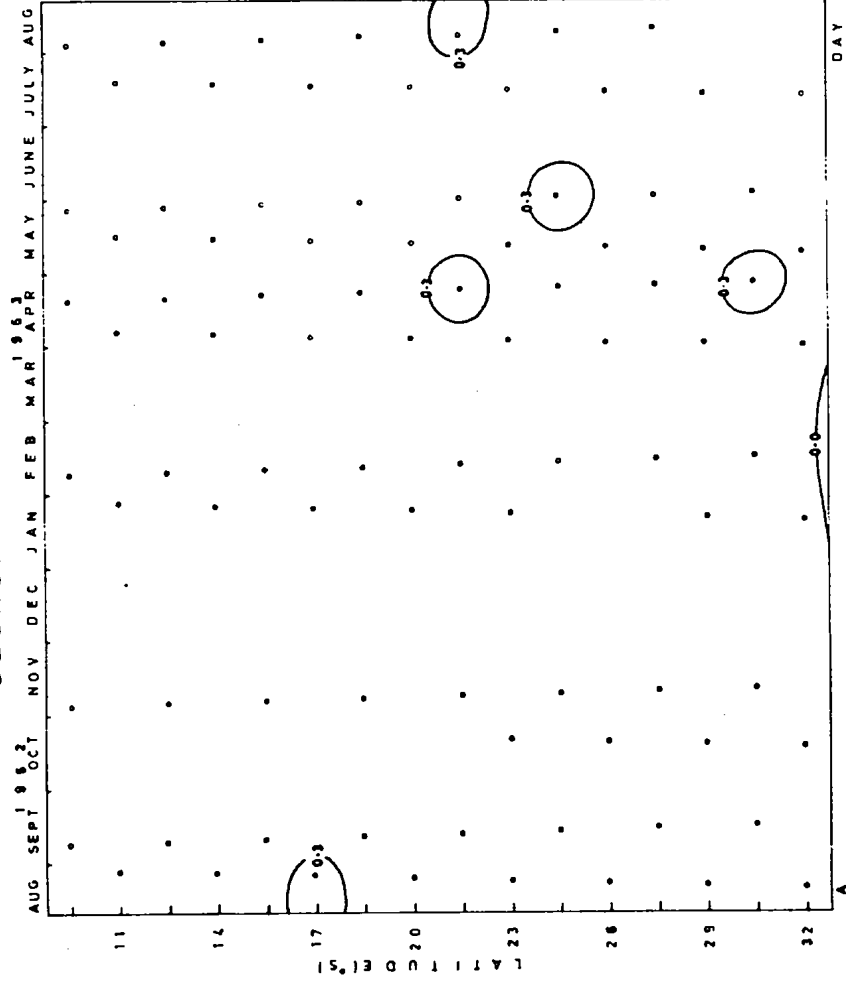


Fig. 6. Latitudinal diurnal and seasonal variations of *Desmopterus gardineri* along 110° E. A. Day, B. Night, Contours Log 10 (No/200 m³).

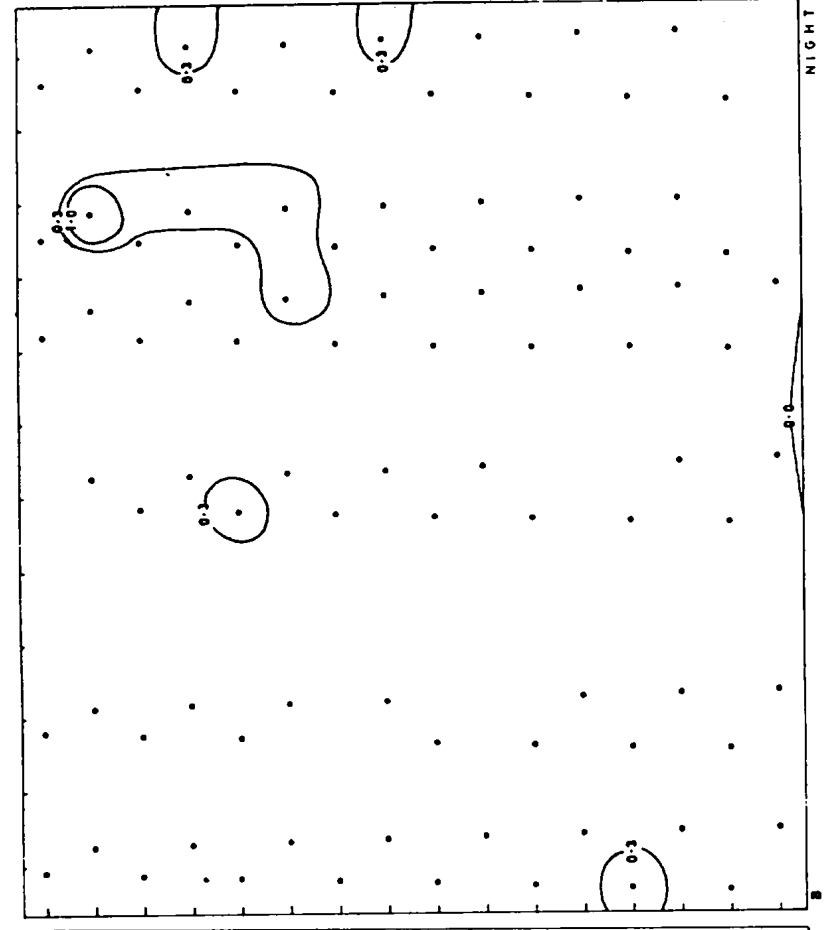


Abb. 6. Tag-Nacht-Verteilung und jahreszeitliche Verteilung von *Desmopterus gardineri* nach der geographischen Breite entlang 110° E. A. Tag. B. Nacht. Isolinien: 1 g (Zahl/200 m³).

DESMOPTERUS PAPILIO

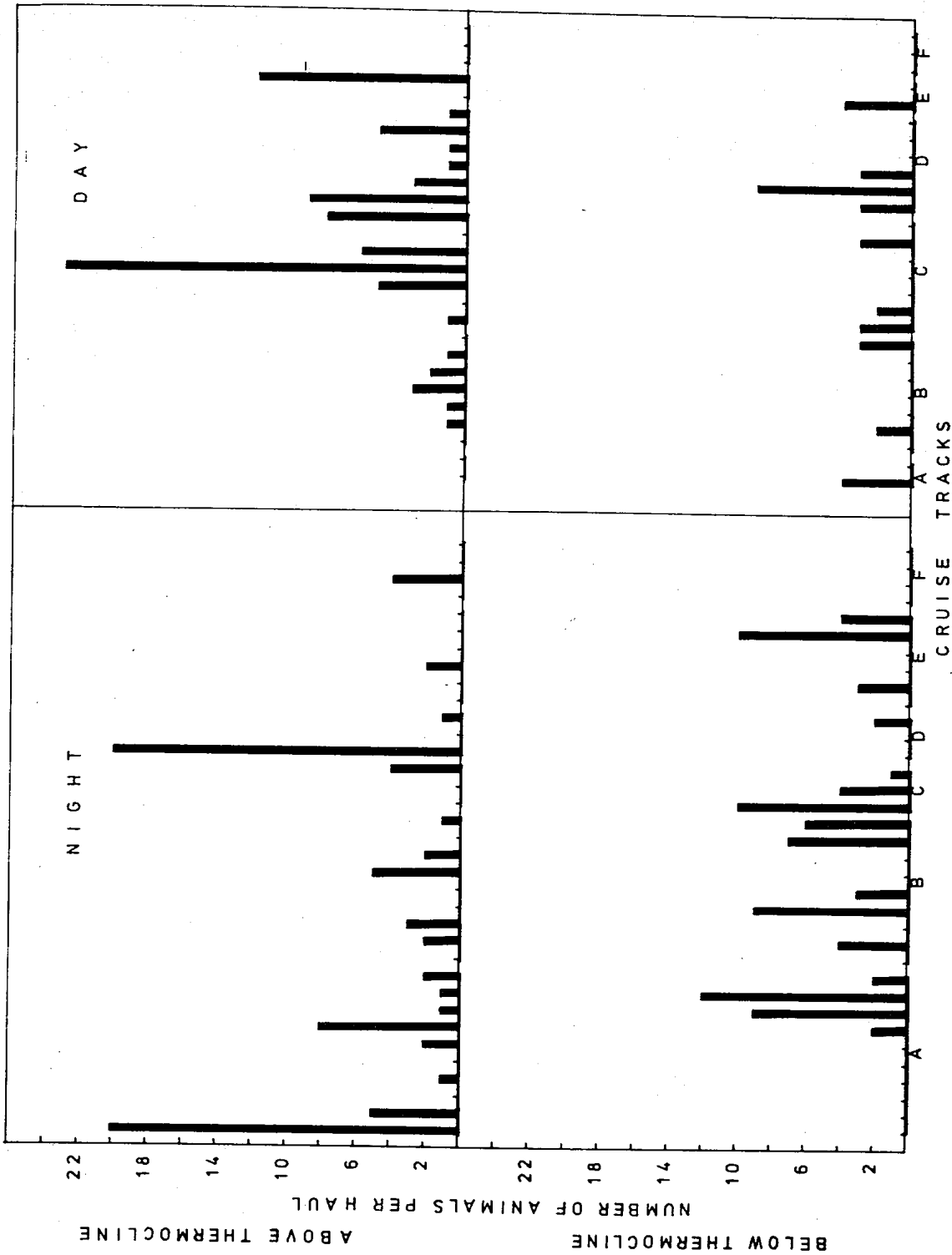


Fig. 7. Distribution of *Desmopterus papilio* in relation to thermocline. Abb. 7. Verteilung von *Desmopterus papilio* in Beziehung zur Temperaturstratumschicht.

DESMOPTERUS GARDINERI

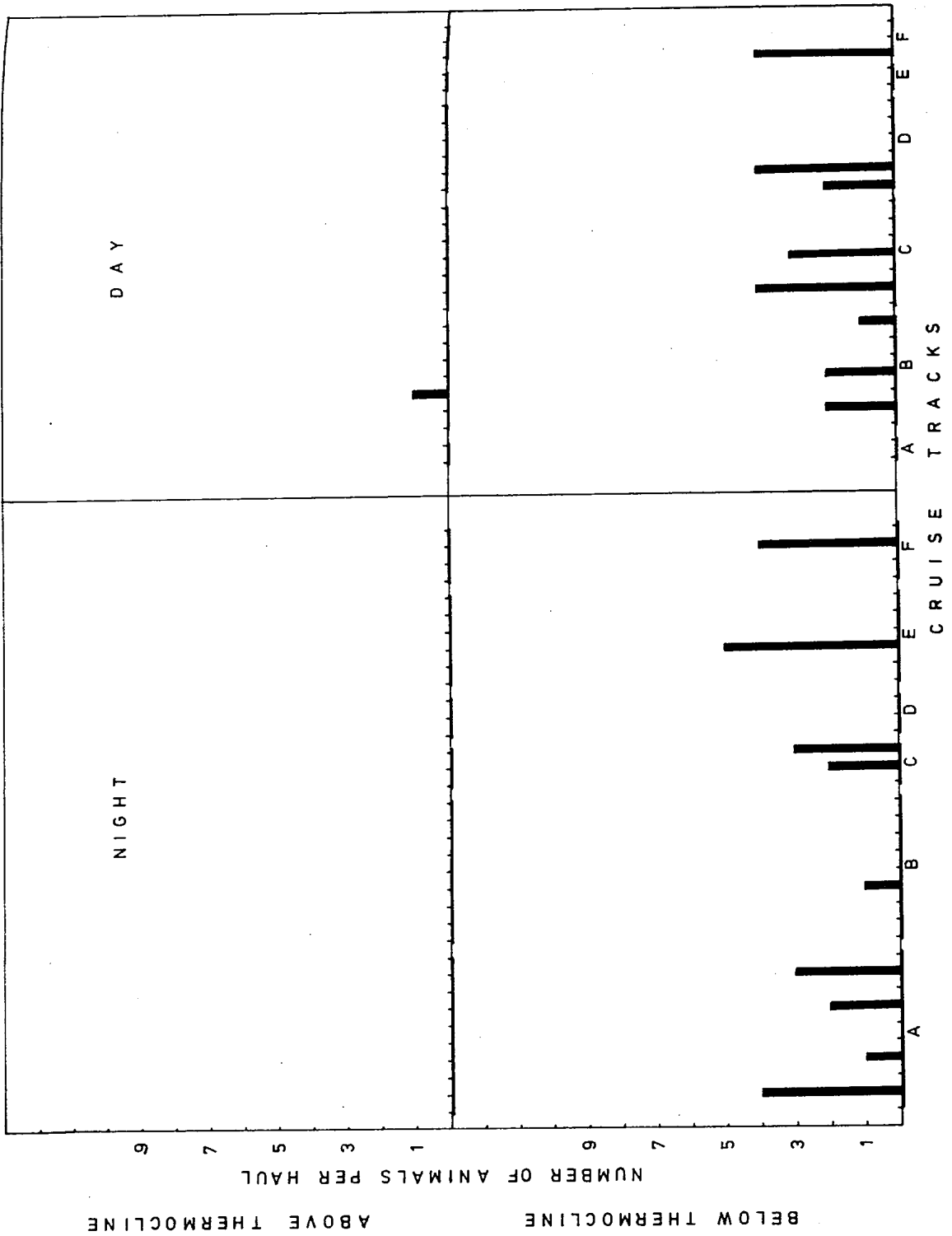


Fig. 8. Distribution of *Desmopterus gardineri* in relation to thermocline.

Abb. 8. Verteilung von *Desmopterus gardineri* in Beziehung zur Temperatursprungschicht.

On the whole it was less abundant below the thermocline during daytime than during the night.

D. gardineri was found very rarely above the thermocline both during day and night (Fig. 8). Almost all the records (17 out of 18) were found below the thermocline. Therefore it seems that the thermocline acts as a barrier for the distribution of this species. The number of organisms was varying from one to five.

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