Macrobenthic communities on the continental shelf of Côte-d'Ivoire. Seasonal and diel cycles in relation to hydroclimate

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Abstract – Benthic communities of the shrimp (*Penaeus notialis*) grounds off Grand-Bassam, Côte-d'Ivoire, exhibit distinct variations, correlated to annual changes in hydroclimate, characterized by warm and cold (upwelling) seasons. These changes appear to be the result of the well-defined reproduction periods of many short-living benthic species, as clearly shown by the peaks of abundance in the samples, at different times of the year, but quite often at the end of the cold and the beginning of the warm seasons (September–November). Many species show marked diel rhythms, either diurnal (pagurids, brachyurans) or nocturnal (macrurans, brachyurans, molluscs), so that the species composition displays distinct differences between day and night samples (February 1970 survey). This diel rhythm can be disturbed at the beginning of the rainy season (May 1969 survey) by the passing of turbid water lenses over the bottom, drifted from the Ébrié lagoon mouth, close to the study site. The diel cycles of some species (stomatopods) appear to be completely altered by the reduced light intensity near the bottom whereas others (some pagurids and brachyurans) are practically unaffected: they seem to be governed by internal physiological mechanisms or they need only a very low threshold of light to maintain their rhythms. So the differences between day and night samples are appreciably reduced, as shown by Correspondence Analysis. © 1999 Ifremer / CNRS / IRD / Éditions scientifiques et médicales Elsevier SAS

benthic fauna / Gulf of Guinea / seasonal cycle / diel cycle / perturbation

Résumé – Communautés macrobenthiques du plateau continental ivoirien : cycles saisonnier et nycthéméral en relation avec les variations hydroclimatiques. Les peuplements benthiques des fonds à pénéides (*Penaeus notialis*) au large de Grand-Bassam (Côte-d'Ivoire) présentent de nettes variations directement liées à celles de l'hydroclimat, caractérisé par la succession de saisons chaudes et froides (*upwellings*). De nombreuses espèces benthiques, à courte durée de vie, ont en effet des périodes de reproduction bien définies qui se traduisent par des pics d'abondance dans les récoltes, à différentes époques de l'année selon les espèces mais, le plus souvent, en fin de saison froide–début de saison chaude (septembre–novembre). De nombreuses espèces benthiques ont des rythmes nycthéméraux très accusés ; leur activité est diurne (la plupart des pagures, certains brachyoures) ou nocturne (de nombreux macroures et brachyoures, quelques mollusques). De ce fait, les récoltes de jour se différencient nettement des récoltes de nuit (observations au cours de la campagne de février 1970). Il arrive cependant (campagne de mai 1969) que les rythmes jour/nuit soient perturbés, vraisemblablement par le passage de lentilles d'eau turbide sur les fonds en début de saison des pluies. Ces eaux sont chargées de matériel particulaire, minéral et organique, provenant de la lagune Ébrié dont le débouché est proche du site d'étude, et où se produit alors un *bloom* de phytoplancton ; la différence entre les éclairements régnant près du fond durant le jour et la nuit serait ainsi très atténuée. Le cycle nycthéméral de certaines espèces apparaît complètement altéré (stomatopodes), tandis qu'il demeure pratiquement inchangé chez d'autres (certains pagures et brachyoures), moins affectées par les variations d'intensité lumineuse : leurs rythmes vitaux seraient plutôt réglés par des processus internes ou leur main-

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tien ne nécessiterait que très peu de lumière. Ce phénomène est sensible quand on considère l'ensemble du peuplement, les différences entre récoltes de jour et de nuit se réduisant de façon notable, comme le mettent en évidence les résultats des analyses factorielles.

faune benthique / golfe de Guinée / cycle saisonnier / cycle circadien / perturbation

1. INTRODUCTION

In the years 1969 and 1970, the peneid shrimp, *Penaeus notialis,* began to be intensively fished along the Côte-d'Ivoire coast [37]. Since this time, the shrimp fishery has affected by a lot of variations [24]. In 1970–1971, about twenty shrimp trawlers landed in Abidjan 600–700 t yr^{-1} of peneids. Then, the catches quickly decreased and remained steady around 400–500 tons until 1979; at the same time the number of vessels also decreased to six from 1976 until 1980 when production fell to 260 tons. This drop in catches led the shrimp trawlers to leave the Côte-d'Ivoire. In 1981–1982 there was no exploitation of the Ivorian shrimp grounds. It resumed in 1983 and progressively the fishing effort increased: nine shrimp vessels were working in 1989. Until 1990 the catch was about 400 t yr^{-1}. But, in 1991, another fall of the catch (180 t) was observed and the production then remained at this level with four vessels regularly exploiting the peneid grounds.

At the very beginning of the shrimp fishery (1969), the *Centre de Recherches Océanographiques* at Abidjan undertook exploratory trawling to study the biology and the dynamics of the exploited populations of this shrimp [11, 24]. Special attention was given to the seasonal evolution and the diel cycle of this peneid species, these biological features being particularly important for the fishing strategy. Exploratory surveys were carried out on the main fishing ground for this species, the Grand-Bassam area (*figure 1*). Species of the benthic invertebrate fauna collected during these exploratory surveys were identified and their abundance recorded.

Our knowledge of the tropical benthic ecosystems (endofauna, trawlable epifauna) remains very limited. The few studies carried out on trawling sample data, in the Gulf of Mexico [16, 17] and in Australia [26] mostly deal with

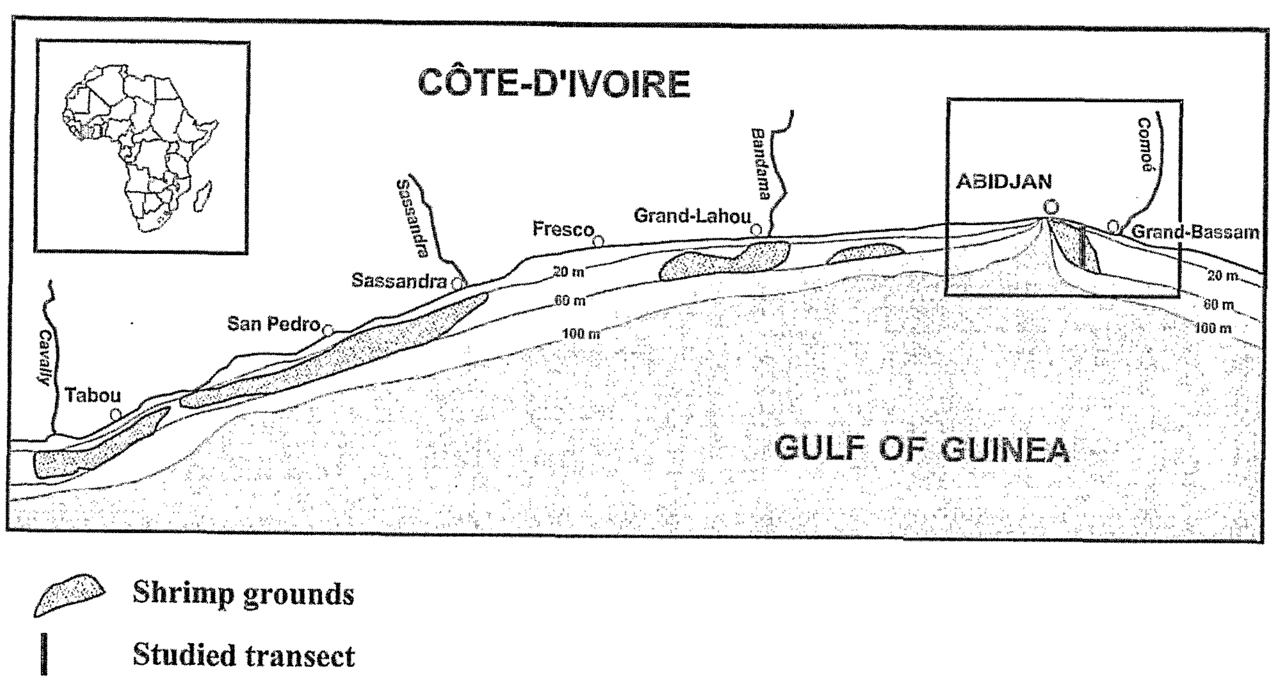

Figure 1. The continental shelf of the Côte-d'Ivoire: shrimp grounds, studied transect and main rivers.

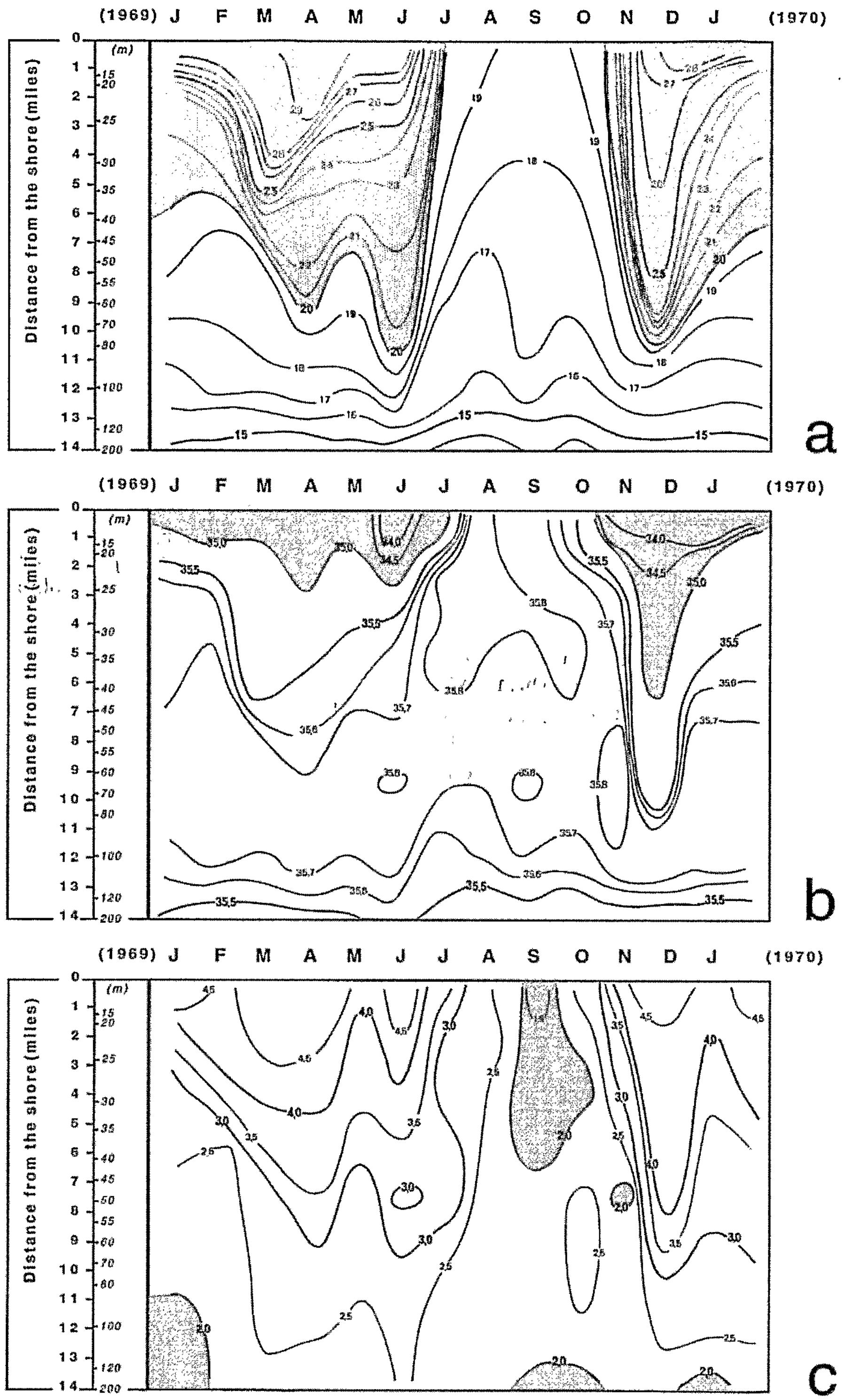

Figure 2. Hydrological conditions at the bottom of the continental shelf off Grand-Bassam (Côte-d'Ivoire) from January 1969 to January 1970. (a) temperature (°C), (b) salinity, (c) dissolved oxygen (ml L^{-1}). Depths shown on the scale of distances from the shore are only markers.

the assessment of the fauna and the description of the communities. For the tropical Atlantic coast of Africa, only studies in Côte-d'Ivoire [21, 23] and Guinea [20] have been published. The information available on seasonal and diel cycles, as presented and discussed in this paper, is also very limited, as seen below.

2. MATERIAL AND METHODS

Monthly cruises were carried out between January 1969 and January 1970 (*table I*) to study the seasonal variations in the *Penaeus notialis* population. Trawl hauls were performed on the continental shelf at depths of 25, 30, 35, 40, 45, 50, 55, 60 m along a north–south transect (3° 49.5' W). The trawling apparatus was a semi-balloon Floridian shrimp trawl, 12 m headrope, 15 m footrope, 28 mm codend mesh (measured with knots stretched), maximum height of the trawl aperture: 3 m (estimation). The hauls lasted one hour and the trawling distance was about 3 nautical miles. Hydrological data (temperature, salinity, dissolved oxygen) were also collected on the bottom at every trawling station and at 15, 20, 70, 80, 100, 200 m depth to cover the whole continental shelf.

Besides these monthly surveys, data were obtained on diel variations in the *Penaeus notialis* ground benthic community. For this purpose, two additional cruises (20–24 May 1969 and 6–10 February 1970) were made at 45 m depth, in the centre of the peneid biotope [11, 24]:

Table I. Cruise dates along the Grand-Bassam transect (3° 49.5' W).

Cruises	Dates	Cruises	Dates
1	14–15/1/1969	8	1–2/8/1969
2	11–12/2/1969	9	26–27/8/1969
3	11–12/3/1969	10	24–25/9/1969
4	10–11/4/1969	11	21–22/10/1969
5	6–7/5/1969	12	18–19/11/1969
6	3–4/6/1969	13	16–17/12/1969
7	1–2/7/1969	14	14–15/1/1970

trawl samples were taken continuously, day and night, during the course of four complete diel cycles and the beginning of a fifth. The sampling apparatus was the same but the hauls lasted only 45 minutes. A total of 39 hauls were obtained during the May cruise and 48 hauls during the February cruise. During every cruise, the total catch was handled on board after each haul: identification of the species (well known as a result of many previous surveys) and counting of all the collected specimens.

Hydrological data were processed in a classical way (drawing of isolines on the bottom over the study year), and through Principal Component Analysis (PCA). Graphs were drawn showing the distribution of abundance throughout the year for the samples of several significant species. Faunal data of the annual cycle study were processed through a Correspondence Analysis (COA) dealing with the marginal distribution of the abundance of species in each cruise (i.e. total number of specimens of each species caught during a cruise). From May

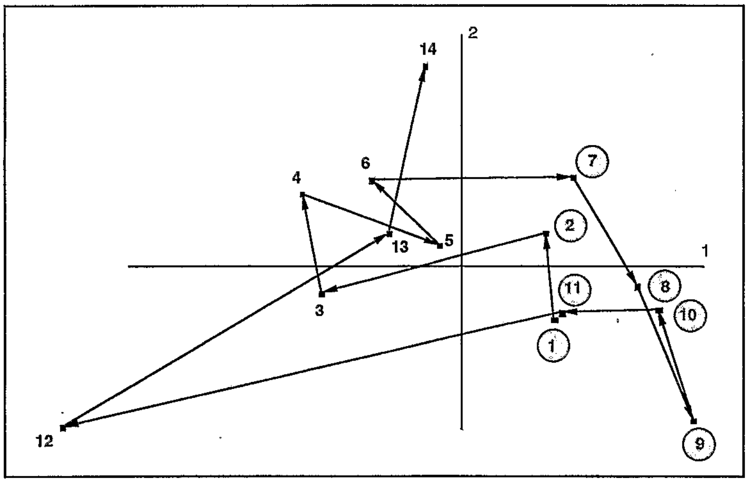

Figure 3. Hydroclimatic cycle from January 1969 to January 1970 (cruises 1 to 14) on the bottom of the continental shelf off Grand-Bassam. Results from a Principal Component Analysis (PCA) on temperature, salinity and dissolved oxygen, in barycentric representation (matrix 108 × 3; % total variance: axis 1: 90.0 %, axis 2: 7.0 %). The data points for the cold seasons are shown in shaded circles.

and February cruise samples, graphs of the diel cycles abundance of some characteristic species were drawn; for each day and night period, the mean values of the species number, total abundance, Shannon's diversity and evenness were plotted over the circadian cycles. The biological data (abundance of the species) were also processed through several COA dealing on one hand with the general matrix species/data, on the other hand with the mean distributions of the abundance of species, during successive day and night hauls, each for a period of 3 hours.

3. RESULTS

3.1. Seasonal data

3.1.1. The hydroclimatic cycle

The hydroclimatic conditions during the study period were characterized by upwelling of cold water in January–February, minor cold season, and again in July–October, major cold season (*figure 2a*). During the latter there was a reduction of the oxygen content of the bottom waters (*figure 2c*), caused by oxidation of organic matter, the production of which is maximum at that time. The two cold seasons alternated with two warm periods: the first, from March to June, marked by strong rainfalls in June (wet season) and a reduction in salinity (*figure 2b*) in shallow waters; the second, from November to January, with a more pronounced reduction in salinity, associated to a high freshwater advection in November from the Bandama and Comoé rivers (rivers with Sahelo-Soudanian regime). A synopsis of the hydroclimatic cycle for the year 1969 is given (*figure 3*), based on PCA carried out on temperature, salinity and dissolved oxygen of the bottom waters, from 25 to 60 m depth, during the cruises (weighted representation of the observation points for each of the cruises, noted 1 to 14). The data points for the cold seasons become distinctly separate from those of the warm seasons; the data point 12 (November) corresponds to the period of high river discharge and hence is located away of the other warm season points.

3.1.2. The seasonal cycle of the benthic fauna

Macrofauna species collected by the shrimp trawls along the transect (*annex I*) consisted mostly of cnidarians (sedentary epifauna), crustaceans, molluscs and echinoderms (mobile epifauna, which can sometimes be buried or living in burrows, or superficial endofauna, caught by the trawl, the footrope of which being chained and scraping the bottom). In terms of abundance, the crustaceans (some stomatopods, but mostly decapods), with 59 species and 17 279 specimens out of a total of 22 488, were distinctly dominant.

Month-to-month changes in the abundance of the most commonly occurring species (*figure 4*) showed several seasonal patterns. Thus, the gastropod *Murex varius* and the pagurid *Diogenes ovatus* were especially abundant in the minor cold season, the scyllarids *Scyllarus caparti* and *Scyllarus posteli* at the beginning of the warm season (March) and at the beginning of the major cold season (July–August). Catches of the brachyurans *Portunus inaequalis* and *Callinectes pallidus* showed a peak at the beginning of the major cold season (July–August); the urchin *Schizaster edwardsi* in the middle of this period (August–September). The brachyuran *Macropipus rugosus*, the peneid *Sicyonia galeata*, the opisthobranch *Pleurobranchaea gela*, the bivalve *Lissochlamys exoticus*, the alcyonarian *Metalcyonium violaceum* had a peak of abundance during the course of the second part of the warm season (November–December). This last form of seasonal abundance is common to many species.

Time-to-time changes in abundance of species followed a seasonal cycle as indicated by COA in which each of the four hydroclimatic periods is clearly identified (*figure 5*): faunistic changes in the communities match with the physical environment changes.

3. 2. The diel cycles in the two studied periods on the shrimp (*Penaeus notialis*) fishing grounds

3.2.1. Hydroclimatology

The hydrological conditions at 45 m depth during the two study periods were both typical of a warm season situation: temperature 20.4 (May, 1969) and 22.5 °C (February, 1970); salinity 35.7 and 35.5; dissolved oxygen 2.9 and 3.8 ml L^{-1}. The beginning of the minor cold season generally varies from year to year and unlike 1969, the minor cold season in Côte-d'Ivoire in 1970 began only in March.

Nevertheless surface observations at a reference station not far from the Grand-Bassam transect (4° 02' W, at 20 m bottom depth) showed that the salinity fell from 34.8 (2 May 1969) to 31.7 (27 May 1969), while, from 31 January 1970 to 14 February 1970, salinity remained

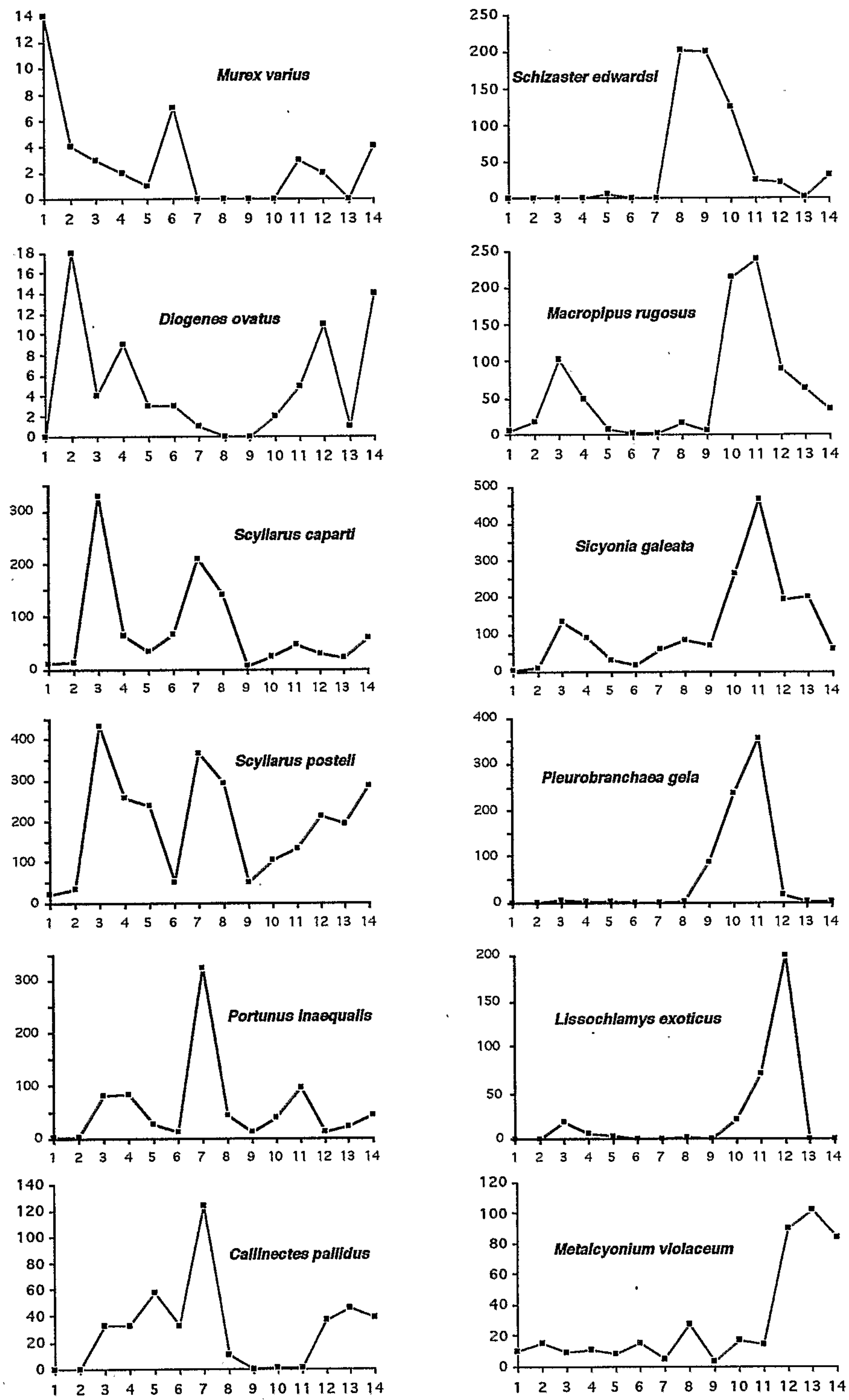

Figure 4. Examples of variations in the catch per cruise (total on all the transect hauls) of some species showing peaks of abundance at well-defined periods of the year.

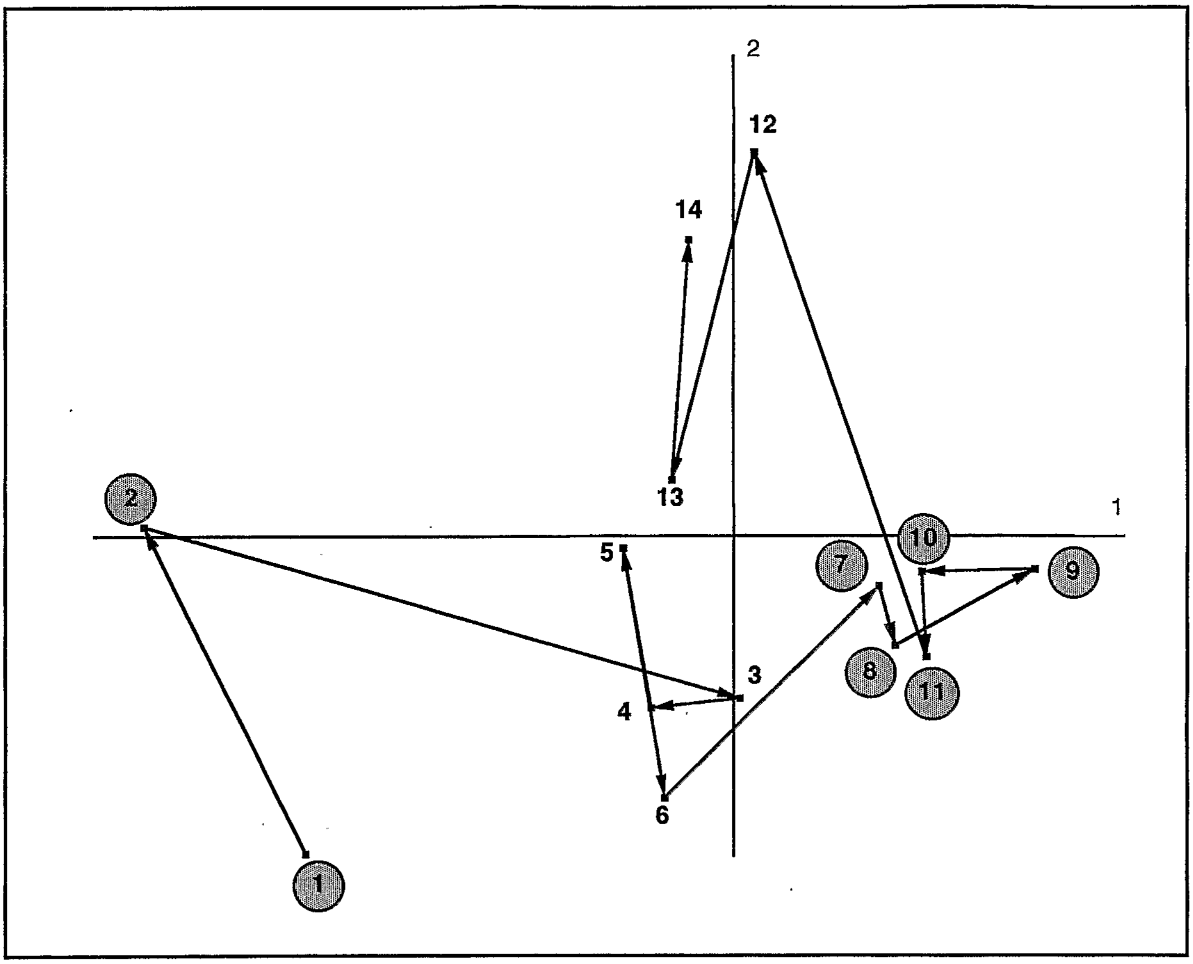

Figure 5. Changes in the faunal composition of the benthic communities from January 1969 to January 1970 (cruises 1 to 14) on the continental shelf off Grand-Bassam. Results of a Correspondence Analysis (COA) on the marginal distribution of the number of individuals of each species in each cruise (matrix 104 × 14; % total variance, axis 1: 18.7 %, axis 2: 15.1 %). The data points for the cold seasons are shown in shaded circles.

almost steady at 34.6 [33]. In 1969, the wet season, which usually peaks in June in the littoral of the Côte-d'Ivoire, had begun by late April–early May: some heavy rainfall had already occurred in the Abidjan and Grand-Bassam region [7] prior to the May cruise dates (*figure 6*). Conversely, during the weeks preceding the February 1970 cruise, rainfall values were quite low.

3.2.2. The fauna nyctimeral rhythms

The community associated with the shrimp fishing grounds is characterized by the scyllarids *Scyllarus caparti, Scyllarus posteli*, the peneid *Sicyonia galeata*, the pagurid *Pagurus cuanensis*, the brachyurans *Medorippe lanata, Machaerus oxyacantha*, the gastropods *Architectonica nobilis, Sigaretus concavus, Distorsio ridens, Metula cumingi, Lathyrus filosus, Cancellaria cancellata, Clavatula muricata* and the bivalve *Pitar elata* [23]. All these species and the others collected by the shrimp trawl on the 45 m depth grounds off Grand-Bassam (including the peneids *Sicyonia galeata, Solenocera africana* and the carid *Pontocaris cataphracta*) live on or very near the bottom and do not exhibit vertical migrations (*Annexes 2* and *3*). They can be classified into three behavioural groups [23]. The first includes diurnally active species (majority of pagurids, some brachyurans, some asterids), the second, nocturnally active species (stomatopods, shrimps, a majority of

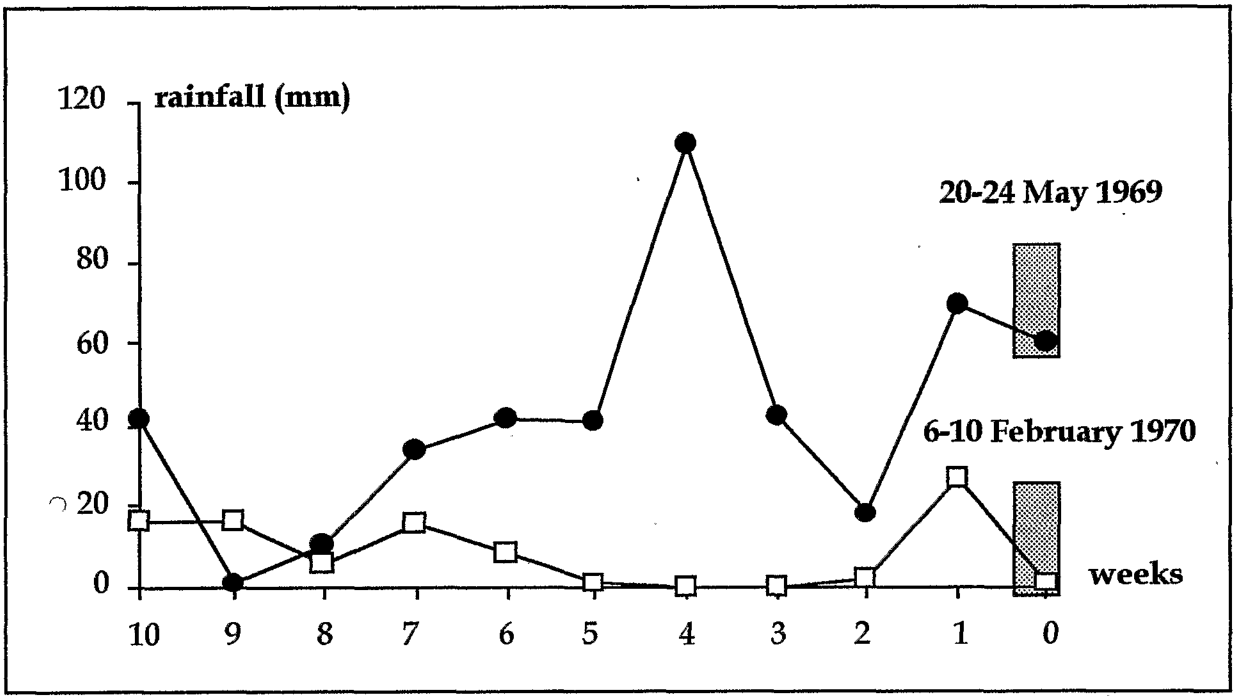

Figure 6. Rainfall in the area of Abijan and Grand-Bassam in the weeks preceding the 20–24 May 1969 and the 6–10 February 1970 cruises.

brachyurans, some gastropods), and the third, those species that are insensitive to day/night alternations (gastropods, echinids). This was the situation observed during the February 1970 cruise. On the other hand, a different situation prevailed during the May 1969 cruise: while the behaviour of some invertebrates such as the pagurid *Paguristes mauritanicus* (diurnal) or the brachyuran *Macropipus rugosus* (nocturnal) remained essentially unaltered (*figure 7*), a number of other species exhibited more or less altered nyctimeral rhythms, becoming insensitive to the day/night succession, or even quasi-diurnal, notably the very nocturnal stomatopods *Squilla cadenati* and *Squilla mantis* especially during the second and third day of the cruise (*figure 7*).

The structural parameters of the community (number of species, abundance, Shannon's diversity and evenness) fluctuated between day and night samples. In February 1970, the number of species (*figure 8a*) and the abundance (*figure 8b*) values were systematically higher at night than during the day, whereas the reverse pattern occurred for diversity (*figure 8c*) and evenness (*figure 8d*). Conversely, in May 1969, the number of species was always much higher during the day than in the night, but showed a decreasing trend from the beginning to the end of the study period. The abundance of individuals was more irregular than in February, with a strong decrease from the fourth day onwards. The diversity and evenness indices tended to have lower values from the second to the third night; but, as a consequence of the low numbers of organisms in the collections, the highest evenness values were obtained on the fourth day.

The COA dealing with the faunal data of the two cruises (*figure 9*) shows that in both cases the composition of the day hauls differed from that of the night hauls. This difference was much more marked for the February cruise data. A direct comparison of the data of February and May in another COA carried out on the successive day and night mean data (*figure 10*), shows evidence for a deregulation of the nycthemeral rhythms of the fauna in May compared to February. In fact, during the February cruise, the faunal composition of the day and night hauls, respectively, remained almost identical over the sampling period, day and night samples being distinctly separate. In contrast, during the May cruise, the faunal composition of the second and third days' collections became closer to those of the night collections. In addition, the difference in the position of the data points between the May and the February cruises may reflect the

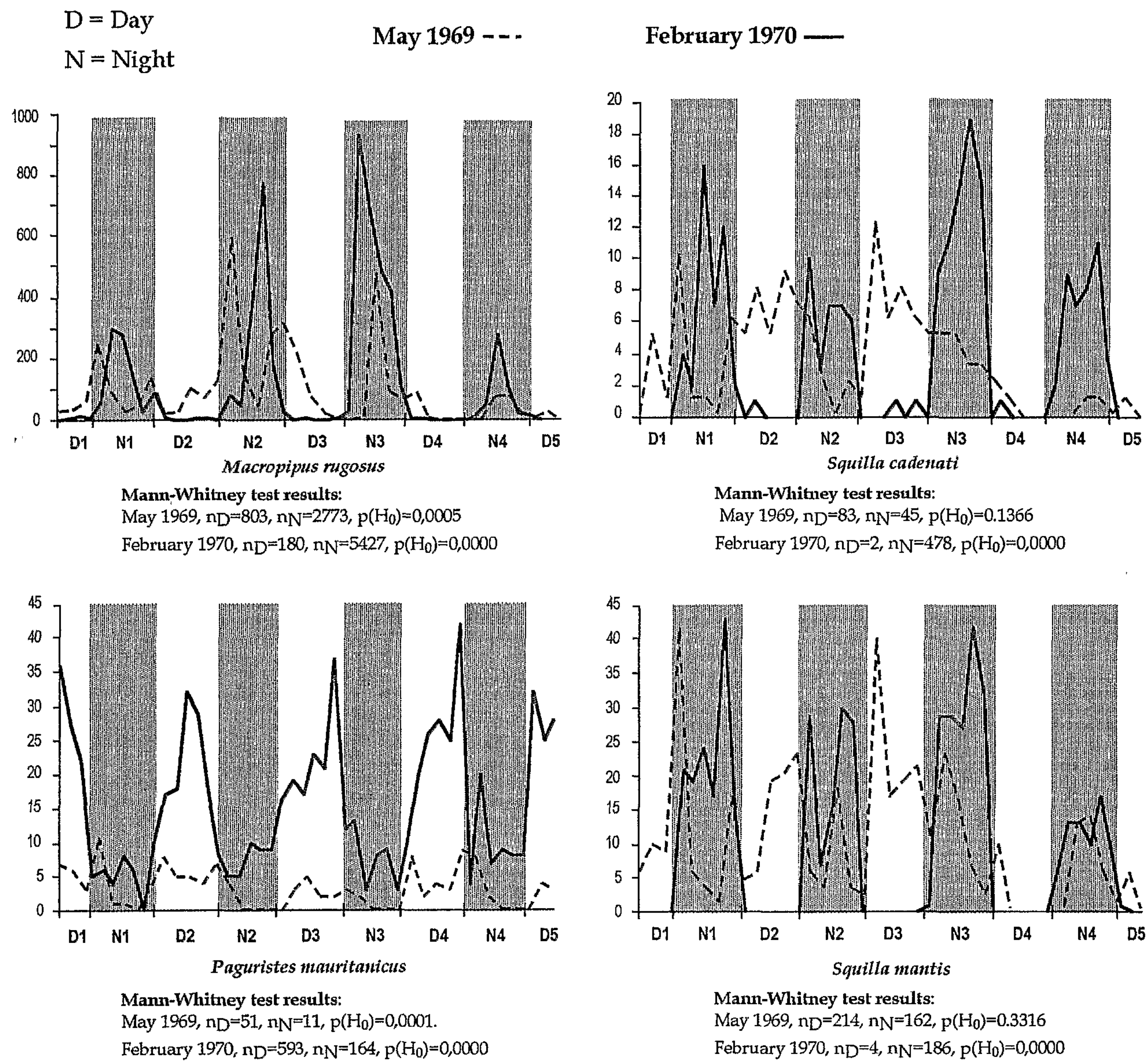

Figure 7. Some examples of nyctimeral rhythms (number of individuals) on the 45 m depth bottom off Grand-Bassam: nocturnal (the brachyuran *Macropipus rugosus*), diurnal (the pagurid *Paguristes mauritanicus*), both little affected by variations in environmental conditions (light penetration to the bottom disturbed by turbid waters inputs in May); nocturnal in normal conditions but highly perturbed by these events in May (the stomatopods *Squilla cadenati* and *Squilla mantis*). For each of these species, highly significant differences are found between night and day distributions (Mann-Whitney test) except both *Squilla* distributions in May where no significant difference was observed.

seasonal cycle fluctuations of the fauna, as described earlier.

The circadian cycles, when examined on the basis of successive 3 hour sections, do not show any substantial difference between the two cruises (*figure 11*), but the night variations of the fauna are stronger than the day variations in both periods.

4. DISCUSSION

4.1. The seasonal cycle

As seen by changes in abundances of the most common species (*figure 4*), many of them showed one peak, and several two peaks of abundance at different times of the

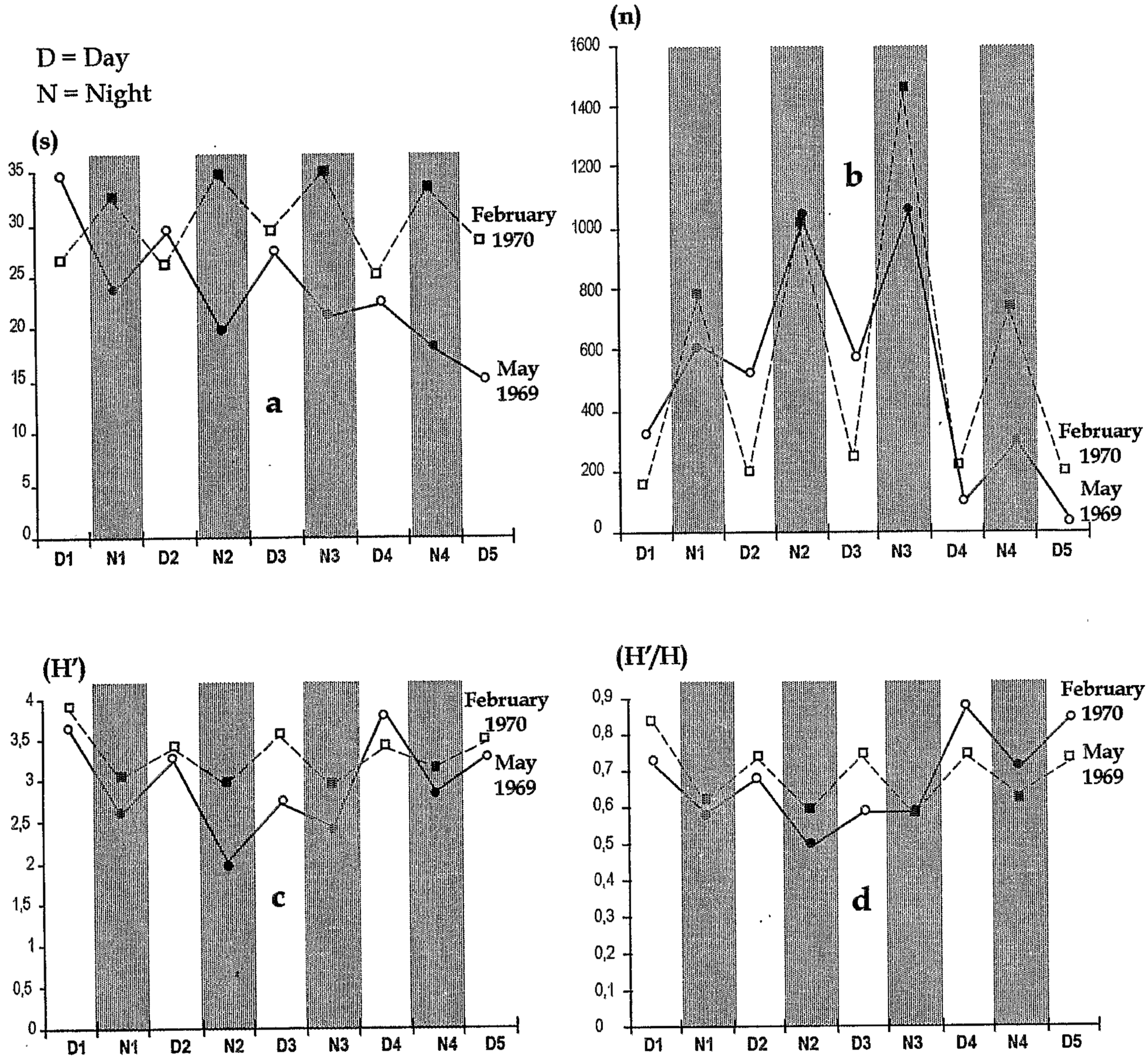

Figure 8. Variations of structural parameters (mean values per successive days and nights) of the community associated with the *Penaeus notialis* grounds. (a) species number, s; (b) number of individuals, n; (c) Shannon's diversity, H'; (d) evenness, H'/H. Solid lines: May 1969 cruise; dashed lines: February 1970 cruise.

year, mostly during the warm season. These tropical organisms with a short life span have specific reproduction periods [2] and their cohorts, after recruitment to the benthic communities, decreased rapidly in abundance in the following months. So, at each period of the annual hydroclimatic cycle (and the year 1969 is an example that agrees with the pattern described by Morlière [31]), the communities are characterized by a particular species composition and faunal structure. Such seasonal phenomena in the large size epifauna (caught with fish trawls) and in the small epifauna and endofauna (collected with a grab) of the Côte-d'Ivoire continental shelf have been previously shown by Le Loeuff and Intès [21, 22].

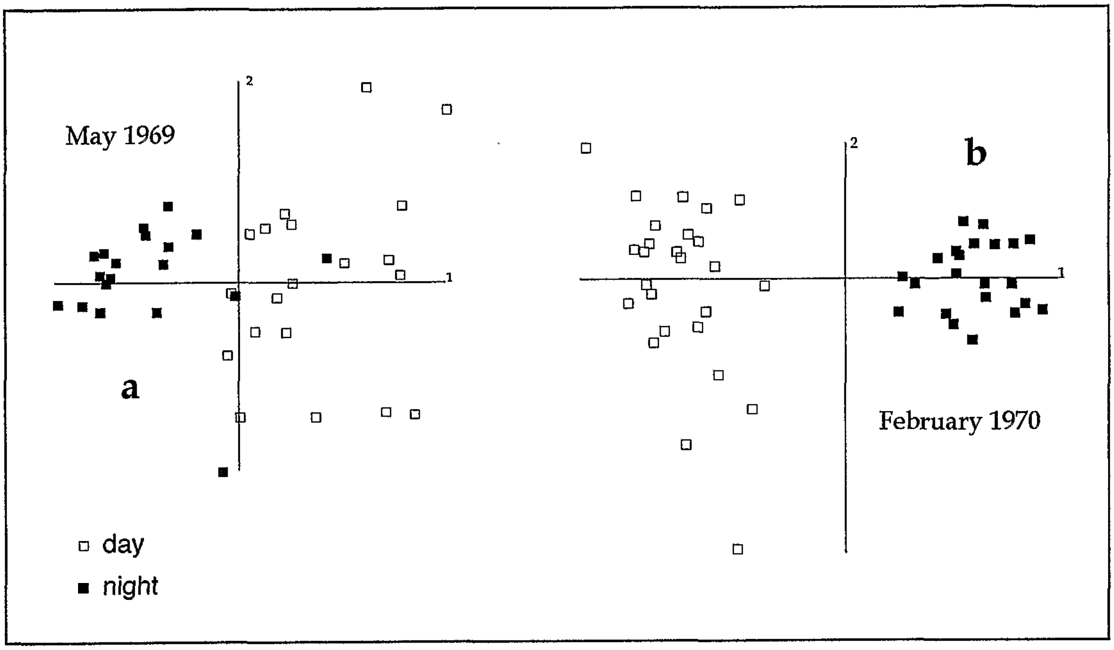

Figure 9. Representation of samples collected during the May 1969 (a), and February 1970 (b) cruises. Results from Correspondence Analysis (COA) on species/data matrix (May, matrix 56 × 39; % total variance, axis 1: 18.4 %, axis 2: 8.8 %. February, matrix 70 × 48; % total variance, axis 1: 21.7 %, axis 2: 6.6 %).

The main seasonal changes in the coastal marine waters ecosystems of the Côte-d'Ivoire are due to the periodical upwelling of cold waters along the coast during the boreal summer. The influence of the succession of rainy/dry seasons (variation of the salinity of the superficial waters) becomes of minor importance. Generally, in tropical oceanic areas without upwelling, differences in the faunal composition and structure of the trawlable benthic communities are observed between the dry and rainy seasons as in the Gulf of Mexico [18, 25]. In a subtropical region (Moreton Bay, Queensland, Australia) where the waters appear to be getting cooler in austral winter, Jones [19] observed at that time a drastic impoverishment of the large mobile epibenthos (mostly Portunidae, Squillidae, Scyllaridae, Penaeidae). In Côte-d'Ivoire, during the upwelling season the fauna is also at a lower level (number of species and abundance) [23].

4.2. The diel cycle

Some species had the same behaviour in both cruises. Like *Paguristes mauritanicus*, other species maintain diurnal activity: the pagurid *Pagurus alatus* (pagurs have an opportunistic feeding strategy [34]); the brachyuran *Calappa pelii* (species belonging to the genus *Calappa* are known to feed during the day upon molluscs and pagurids [40]); the predator asterids, *Astropecten irregularis* and *Luidia heterozona* that keep buried during the night (in asterids, the diel cycle varies with the species [1, 28, 29]); the cnidarian *Metalcyonium violaceum* that probably retracts its polyps and contracts its body by night [36]. In the same way as the predator brachyuran *Macropipus rugosus*, the scyllarid *Scyllarus posteli*, the peneid *Solenocera africana* (the behaviour of the close species, *Solenocera membranacea*, a nocturnal predator, is well described by Heegard, [14]), the brachyuran *Sternodromia spinirostris* keep a nocturnal activity during the February cruise. This latter behaviour is the most common among crustacean species [19, 25] and may serve to minimise predation by demersal fishes during high-risk (daily) periods.

However, from February to May, some variations occurred for instance in the diel cycle of the pagurids *Diogenes ovatus* and *Pagurus cuanensis*, the scyllarid *Scyllarus caparti*, the carid shrimp *Pontocaris cataphracta*, the gastropods *Xenophora senegalensis* and *Cymbium patulum* (a predator of bivalves [27]), while the burrowing stomatopods *Squilla cadenati*, *Squilla mantis*

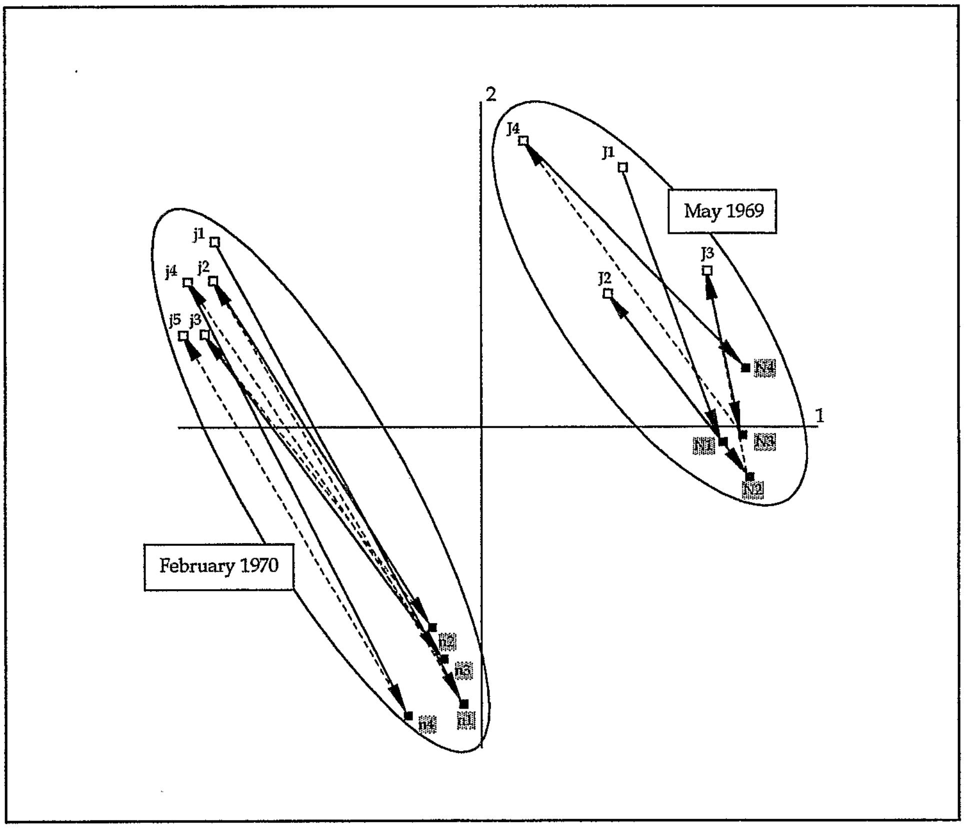

Figure 10. Direct comparison of May and February cruise data. Results from a Correspondence Analysis (COA) on the mean distribution of abundance of species during the course of successive days and nights (matrix 79 × 17; % total variance, axis 1: 37.0 %, axis 2: 22.9 %).

[13], and the brachyurans *Medorippe lanata* and *Machaerus oxyacantha* exhibited completely changed nyctimeral rhythms.

From these results it can be concluded that species such as the two *Squilla* are under the influence of environmental factors, most likely the intensity and wavelength of the light that reaches the sea bottom. The biorhythm of benthic organisms such as *Paguristes* and *Macropipus* may be regulated by internal processes [40] as these species need only a very low threshold of light to maintain their diel cycle. These two hypotheses are also put forward to explain the diel periodicity of deep-water crustaceans, Nephropidae and Caridae, on the northwest Australian continental slope, where the Pacific tropical waters are exceptionally clear and transmissive; at 400–500 m, adequate light may be available to induce the observed day–night pattern activity [39]. The diel patterns of some of these deep-water Australian Nephropidae and of the European species *Nephrops norvegicus* [6, 30, 32] are thought to be very similar.

In May 1969, something happened to prevent or strongly limit light penetration to the bottom. The consequence of the increased rainfall in April–May was an increased flow from the Ébrié lagoon fed by coastal rivers: the water level of the lagoon began to rise from May and the salinity of the lagoon waters at the zone of its confluence with the sea decreased sharply [10, 38]. In 1975, when the quantity and the pattern of rainfall was quite similar to those of 1969, Dufour [9] observed in May the incidence of a very high phytoplankton biomass in the estuarine part of the lagoon. Taking into account these observations, it can be postulated that turbid water lenses loaded with inorganic and organic particulate material flowing out of the Ébrié lagoon could have been transported to and over the studied area by the eastward-flowing Guinea current, stronger at this time of the year [8]. The consequence of this would be, if not a total absence, at least a

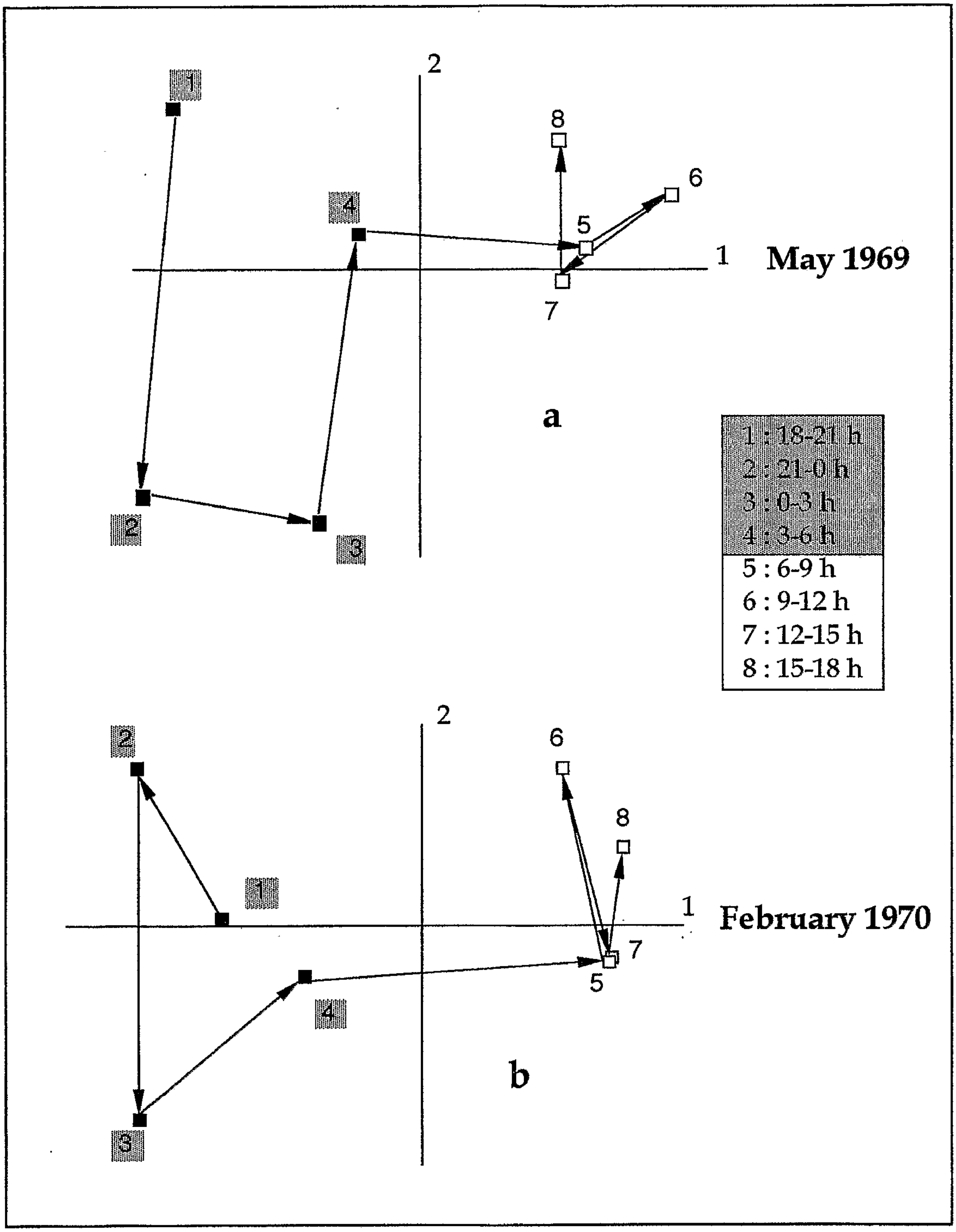

Figure 11. Average diel cycles of the community during the May (a) and February (b) cruises. Results of a Correspondence Analysis (COA) on the mean distribution abundance of the species in successive 3 hour periods (May, matrix 56 × 8; % total variance, axis 1: 47.0 %, axis 2: 16.2 %. February, matrix 70 × 8, % total variance, axis 1: 61.4 %, axis 2: 13.9 %).

sharp reduction of light reaching the bottom, inhibiting the nyctimeral rhythms in several species. This change apparently occurred from the second day of the May cruise, but, at the beginning of the fourth day, the fauna recovered a circadian rhythm closer to normal. It is also interesting to note that the changes in the abundance and species number of the benthic fauna in the hauls of May suggest, though difficult to substantiate, an impoverishment of the bottom following repeated trawls at the same site (*figure 8a* and *b*), whereas nothing of this sort was observed during the course of the February 1970 cruise where a greater number of hauls were made. Nevertheless such a phenomenon has been observed on a prawn fishing ground of Australia [12].

5. CONCLUSION

In Côte-d'Ivoire, a tropical oceanic area with strong annual variations of the hydroclimate (upwelling), notable seasonal changes can be observed in the faunistic composition and structure of the benthic communities on the continental shelf. The warm season fauna is richer (in abundance and in number of species) than the cold season fauna; each of them is characterized by particular species. In fact, it is the whole ecosystem of the Ivorian oceanic area that changes with the hydroclimatic seasonal cycle [8, 31]: nutrient salts [15], primary production [35], zooplankton [3], benthic fauna [21, 22, 23], demersal fishes [5]. Seasonal variations are also observed in the *Penaeus notialis* population [11, 24]: catches are lower in the middle of the warm season (from January to March) and remained at a higher level during other months; the bathymetric distribution of this peneid species also changes during the cold season (July to September) when the higher catch is obtained on the 35 m depth bottoms, instead of 45 m.

Diel cycles have also been studied in zooplankton [4] and demersal fishes [5] from Côte-d'Ivoire. The originality of this study is to show that those rhythms can be perturbed by climatic events. In the same way, *Penaeus notialis* was shown to be a rather nocturnal shrimp, as seen in May 1970 when the catch was three times higher in the night hauls than in the day hauls; but, in February 1969, the night catch was four times lower than the day catch, the better yields being observed at dawn and sunset [11].

A monitoring program of the benthic ecosystem is now starting off Grand-Bassam where this study was carried out. Diurnal and seasonal variations should be taken into account before identifying long-term changes possibly due to climatic changes or to bottom trawling.

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Annex I. Species collected during the cruises off Grand-Bassam (Côte-d'Ivoire) from January, 1969 to January, 1970. Indication is given of their occurrence and total abundance in the hauls and of their observed vertical distribution.

Species	Occurrence	Abundance	Vertical distribution (m)
SPONGES			
Ficulina ficus (Linnaeus, 1767)	2	3	40
CNIDARIANS			
Epizoanthus senegambiensis (Carter, 1882)	2	2	25–50
Balanophyllia floridana (Pourtalès, 1871)	7	11	45–50
Veretillum cynomorium Pallas, 1766	1	1	40
Cavernularia mirifica Tixier-Durivault, 1963	4	5	25
Virgularia tuberculata Marshall, 1883	1	1	30
Alcyonium monodi Tixier-Durivault, 1955	29	71	25–40
Alcyonium altum Tixier-Durivault, 1955	29	1171	30–40
Alcyonium laeve Tixier-Durivault, 1955	3	19	30–40
Metalcyonium violaceum (Tixier-Durivault 1955)	48	410	30–55
Bellonella madseni Tixier-Durivault, 1961	9	123	30–50
POLYCHAETES			
Aphrodita alta Kinberg, 1855	8	11	25–60
Hermodice carunculata (Pallas, 1766)	13	31	35–60
Diopatra neapolitana Delle Chiaje, 1841	10	33	35–60
CRUSTACEANS			
Squilla aculeata calmani Holthuis, 1959	11	30	25–35
Squilla cadenati Manning, 1970	18	80	40–55
Squilla mantis (Linnaeus, 1758)	26	180	25–50
Solenocera africana Stebbing, 1917	6	9	40–45
Metapenaeopsis miersi (Holthuis, 1952)	18	35	25–60
Sicyonia galeata Holthuis, 1952	67	1689	25–55
Parapandalus narval (Fabricius, 1787)	9	131	45–60
Alpheus intrinsecus Bate, 1888	2	2	30–35
Hippolysmata hastatoides (Balss, 1914)	1	12	25
Nematopalaemon hastatus (Aurivillius, 1898)	4	3632	25
Pontocaris cataphracta (Olivi, 1792)	30	65	25–50
Panulirus rissoni Desmaret, 1825	2	2	25
Scyllarus caparti Holthuis, 1952	70	1061	25–55
Scyllarus posteli Forest, 1963	90	2672	25–60
Scyllarides herklotsi (Herklots, 1851)	1	1	35
Stenopus spinosus Risso, 1826	1	1	55
Paguristes difficilis Forest, 1952	1	3	30
Paguristes mauritanicus Bouvier, 1906	43	304	25–60
Paguristes virilis Forest, 1952	1	2	25
Diogenes pugilator Roux, 1829	8	13	25–45
Diogenes ovatus Miers, 1881	26	71	25–50
Petrochirus pustulatus (H. Milne Edwards, 1848)	6	6	25–50
Dardanus arrosor (Herbst, 1796)	2	2	45–50
Dardanus pectinatus (Ortmann, 1892)	31	46	25–45
Pagurus mbizi Forest, 1955	15	25	30–60
Pagurus alatus Fabricius, 1775	47	93	30–60
Pagurus cuanensis Bell, 1846	16	22	30–55
Pagurus triangularis (Chevreux and Bouvier, 1892)	22	43	25–50
Paguridium minimum (Chevreux and Bouvier, 1892)	5	7	40–60
Spiropagurus elegans Miers, 1881	4	4	25–30
Raninoides bouvieri Capart, 1951	1	1	45
Dromia monodi (Forest and Guinot, 1966)	1	1	50
Sternodromia spinirostris (Miers, 1881)	9	23	40–60

Annex I. (continued).

Species	Occurrence	Abundance	Vertical distribution (m)
Homola barbata (Fabricius, 1793)	8	10	40–60
Ethusa vossi Manning and Holthuis, 1981	4	5	35–50
Phyllodorippe armata (Miers, 1881)	49	2413	25–40
Medorippe lanata (Linnaeus, 1767)	69	1226	25–60
Matuta michaelseni Balss, 1921	5	6	25–35
Calappa rubroguttata Herklots, 1851	24	322	25–45
Calappa pelii Herklots, 1851	45	362	30–60
Ilia spinosa Miers, 1881	14	22	30–50
Pseudomyra mbizi Capart, 1951	30	121	45–60
Liocarcinus corrugatus (Pennant, 1777)	6	12	25–45
Macropipus rugosus (Doflein, 1904)	39	846	30–55
Cronius ruber (Lamarck, 1818)	14	21	25–35
Portunus inaequalis (Miers, 1881)	48	802	25–50
Portunus validus Herklots, 1851	17	63	25–35
Callinectes pallidus (de Rochebrune, 1883)	23	412	25–40
Callinectes amnicola (de Rochebrune, 1883)	7	18	25–30
Machaerus oxyacantha (Monod, 1956)	25	105	25–50
Apiomithrax bocagei (Osorio, 1887)	15	25	25–40
Inachus angolensis Capart, 1951	11	19	45–60
Inachus leptochirus Leach, 1817	3	3	40–45
Capartiella longipes (Capart, 1951)	3	3	45–55
Achaeus monodi (Capart, 1951)	1	1	30
Macropodia gilsoni (Capart, 1951)	4	5	40–60
Macropodia spinusola (Miers, 1881)	15	17	30–45
Stenorhynchus lanceolatus (Brullé, 1837)	24	45	30–50
Parthenope notialis Manning and Holthuis, 1981	37	127	40–60
MOLLUSCS			
Calliostoma hernandezi Salazar and Gubbioli, 1993	11	23	30–60
Turritella ungulina Linnaeus, 1758	2	2	35–40
Turritella ligar Deshayes, 1843	2	2	25–30
Turritella annulata Kiener, 1853	6	7	35–55
Architectonica nobilis (Röding, 1798)	2	2	35–40
Xenophora senegalensis Fischer, 1873	18	57	30–55
Natica fanel Recluz, 1843	3	3	25–50
Natica canariensis Ohdner, 1931	1	1	55
Sigaretus concavus Lamarck, 1822	13	38	25–40
Cypraea petitiana Crosse, 1873	2	2	30–35
Phalium saburon Bruguière, 1792	10	11	30–60
Distorsio ridens (Reeve, 1844)	10	26	30–50
Murex cornutus Linnaeus, 1758	6	6	30–55
Murex rosarium Chemnitz, 1788	14	21	30–50
Murex varius Sowerby, 1834	22	40	25–50
Trophon fusulus (Brocchi, 1814)	5	5	45–60
Coralliophila meyendorffi Calcara, 1862	1	1	40
Phos grateloupianus Petit de la Saussaye, 1853	3	3	40–50
Metula cumingi Adams, 1858	4	4	25–60
Nassarius tritoniformis (Kiener, 1835)	3	5	25
Nassarius turbineus (Gould, 1845)	4	5	50–60
Lathyrus filosus Schubert and Wagner, 1829	5	5	30–45
Fusus caparti Adam and Knudsen, 1955	3	3	30–35
Tudicla afra Gmelin, 1790	11	29	30–55
Cymbium glans (Gmelin, 1791)	2	2	25–30

Annex I. (continued).

Species	Occurrence	Abundance	Vertical distribution (m)
Cymbium patulum (Broderip, 1830)	27	46	35–60
Cymbium souliei Marche-Marchad, 1974	3	5	25
Cancellaria cancellata Linnaeus, 1767	6	6	30–60
Marginella cincta Kiener, 1834	3	3	30–40
Drillia rosacea (Reeve, 1845)	4	4	30–50
Clavatula muricata (Lamarck, 1822)	2	3	30–40
Clavatula diadema Kiener, 1841	11	20	40–60
Clavatula lelieuri (Recluz, 1851)	10	11	25–55
Clavatula aculeiformis (Lamarck, 1822)	1	1	25
Turris undatiruga (Bivona, 1832)	2	2	50–60
Turris consociata (Smith, 1877)	1	1	45
Genota mitraeformis (Wood, 1828)	4	6	40–50
Genota nicklesi Knudsen, 1952	1	2	25
Terebra corrugata Lamarck, 1822	9	9	30–55
Hydatina physis Linnaeus, 1758	1	2	30
Philine aperta Linnaeus, 1767	26	215	25–50
Pleurobranchaea gela Marcus and Marcus, 1966	27	708	25–50
Marionia pusa Marcus and Marcus, 1968	2	2	35–40
Fimbria fimbria (Linnaeus, 1767)	16	129	25–55
Armina adami White, 1955	1	4	40
Armina bayeri Marcus and Marcus, 1966	7	8	25–35
Nucula nitidosa Winckworth, 1930	5	9	45–60
Nucula sulcata Bronn, 1831	1	4	60
Lissochlamys exoticus (Dillwyn, 1817)	9	320	25–30
Aequipecten minutus (Nicklès, 1955)	1	1	45
Crassatella paeteli Maltzan, 1885	1	1	50
Crassatella triquetra Reeve, 1842	4	6	40–55
Cardita umbonata (Sowerby, 1904)	1	1	60
Pitar elata (Sowerby, 1908)	1	2	60
ECHINODERMS			
Antedon dubenii Bölsche, 1866	44	290	25–55
Astropecten irregularis Pennant, 1777	24	62	30–50
Astropecten michaelseni Koehler, 1914	14	40	25–40
Astropecten jarli Madsen, 1950	1	1	50
Astropecten hupferi Koehler, 1914	1	1	50
Luidia atlantidea Madsen, 1950	34	139	25–50
Luidia heterozona Fisher, 1940	46	105	25–60
Luidia numidica Koehler, 1911	21	30	25–50
Centrostephanus longispinus (Philippi, 1845)	18	25	40–60
Genocidaris maculata A. Agassiz, 1869	3	17	35–40
Schizaster edwardsi Cotteau, 1889	13	611	25–45
Hemioedema goreensis Cherbonnier, 1949	5	5	25–35
BRYOZOANS			
Cupuladria canariensis (Busk, 1859)	21	118	30–60
Hippoporidra senegambiensis (Carter, 1882)	10	39	40–50

Annex II. Species collected during the May 1969 cruise on the 45 m depth bottoms off Grand-Bassam (Côte-d'Ivoire) with indication of their occurrence and total abundance in the day (D) and night (N) hauls.

Species	Occurrence D	Occurrence N	Abundance D	Abundance N
SPONGES				
Ficulina ficus (Linnaeus, 1767)	4	**0**	4	**0**
CNIDARIANS				
Balanophyllia floridana (Pourtalès, 1871)	1	**0**	1	**0**
Alcyonium altum Tixier-Durivault, 1955	1	**0**	1	**0**
Metalcyonium violaceum (Tixier-Durivault, 1955)	19	**15**	131	**63**
Bellonella madseni Tixier-Durivault, 1961	3	**3**	3	**6**
POLYCHAETES				
Diopatra neapolitana Delle Chiaje, 1841	1	**0**	1	**0**
CRUSTACEANS				
Squilla cadenati Manning, 1970	14	**15**	83	**45**
Squilla mantis (Linnaeus, 1758)	14	**19**	214	**162**
Solenocera africana Stebbing, 1917	2	**15**	5	**140**
Metapenaeopsis miersi (Holthuis, 1952)	1	**2**	1	**2**
Sicyonia galeata Holthuis, 1952	20	**19**	573	**2278**
Parapandalus narval (Fabricius, 1787)	0	**1**	0	**1**
Alpheus intrinsecus Bate, 1888	0	**1**	0	**1**
Pontocaris cataphracta (Olivi, 1792)	10	**11**	27	**59**
Scyllarus caparti Holthuis, 1952	20	**19**	1394	**1649**
Scyllarus posteli Forest, 1963	20	**19**	2710	**5304**
Paguristes mauritanicus Bouvier, 1906	20	**8**	91	**35**
Diogenes pugilator Roux, 1829	1	**0**	1	**0**
Diogenes ovatus Miers, 1881	18	**7**	102	**21**
Petrochirus pustulatus (H. Milne Edwards, 1848)	2	**2**	2	**2**
Dardanus pectinatus (Ortmann, 1892)	13	**4**	19	**4**
Pagurus mbizi Forest, 1955	5	**2**	9	**2**
Pagurus alatus Fabricius, 1775	20	**8**	51	**11**
Pagurus cuanensis Bell, 1846	11	**2**	19	**3**
Pagurus triangularis (Chevreux and Bouvier, 1892)	3	**0**	8	**0**
Paguridium minimum (Chevreux and Bouvier, 1892)	0	**1**	0	**1**
Sternodromia spinirostris Miers, 1881	4	**13**	4	**30**
Homola barbata (Fabricius, 1793)	0	**2**	0	**5**
Ethusa vossi Manning and Holthuis, 1981	1	**0**	1	**0**
Phyllodorippe armata (Miers, 1881)	2	**0**	2	**0**
Medorippe lanata (Linnaeus, 1767)	19	**19**	505	**490**
Calappa rubroguttata Herklots, 1851	5	**1**	5	**1**
Calappa pelii Herklots, 1851	13	**6**	29	**8**
Ilia spinosa Miers, 1881	9	**3**	12	**3**
Macropipus rugosus (Doflein, 1904)	19	**19**	803	**2776**
Portunus inaequalis (Miers, 1881)	17	**17**	249	**603**
Leopoldius pisifer (MacLeay, 1838)	1	**0**	1	**0**
Machaerus oxyacantha (Monod, 1956)	15	**9**	73	**23**
Macropodia spinusola (Miers, 1881)	1	**1**	1	**1**
Stenorhynchus lanceolatus (Brullé, 1837)	7	**10**	11	**13**
Parthenope notialis Manning and Holthuis, 1981	17	**13**	57	**31**
MOLLUSCS				
Calliostoma hernandezi Salazar and Gubbioli, 1993	7	**3**	8	**3**
Turritella annulata Kiener, 1853	3	**0**	3	**0**
Architectonica nobilis (Röding, 1798)	3	**1**	4	**1**
Xenophora senegalensis Fischer, 1873	13	**6**	24	**8**
Natica canariensis Ohdner, 1931	0	1	0	1

Annex II. (continued).

Species	Occurrence D	Occurrence N	Abundance D	Abundance N
Phalium saburon Bruguière, 1792	1	3	1	4
Distorsio ridens (Reeve, 1844)	5	**2**	6	**2**
Tonna galea Linnaeus, 1758	0	**2**	0	**2**
Murex cornutus Linnaeus, 1758	4	**1**	6	**2**
Murex rosarium Chemnitz, 1788	7	**4**	8	**5**
Murex varius Sowerby, 1834	3	**3**	5	**2**
Trophon fusulus (Brocchi, 1814)	1	**0**	0	**1**
Coralliophila kraemmeri Knudsen, 1956	1	**0**	1	**0**
Phos grateloupianus Petit de la Saussaye, 1853	4	**2**	4	**2**
Metula cumingi Adams, 1858	2	**0**	2	**0**
Nassarius turbineus (Gould, 1845)	3	**0**	3	**0**
Lathyrus filosus Schubert and Wagner, 1829	1	**0**	2	**0**
Tudicla afra Gmelin, 1790	11	**2**	16	**3**
Cymbium patulum (Broderip, 1830)	8	**11**	13	**31**
Cancellaria cancellata Linnaeus, 1767	2	**1**	2	**1**
Marginella cincta Kiener, 1834	1	**1**	2	**1**
Clavatula muricata (Lamarck, 1822)	0	**1**	0	**1**
Clavatula diadema Kiener, 1841	5	**2**	5	**3**
Clavatula lelieuri (Recluz, 1851)	1	**1**	1	**2**
Clavatula aculeiformis (Lamarck, 1822)	1	**1**	1	**1**
Turris undatiruga (Bivona, 1832)	1	**0**	1	**0**
Genota mitraeformis (Wood, 1828)	2	**1**	2	**1**
Terebra corrugata Lamarck, 1822	1	**0**	1	**0**
Philine aperta Linnaeus, 1767	8	**3**	15	**5**
Pleurobranchaea gela Marcus and Marcus, 1966	0	**3**	0	**3**
Marionia pusa Marcus and Marcus, 1968	1	**0**	1	**0**
Fimbria fimbria (Linnaeus, 1767)	4	**0**	4	**0**
Crassatella triquetra Reeve, 1842	2	**0**	2	**0**
ECHINODERMS				
Antedon dubenii Bölsche, 1866	4	**5**	4	**6**
Astropecten irregularis Pennant, 1777	14	**6**	21	**7**
Astropecten jarli Madsen, 1950	3	**1**	3	**2**
Luidia atlantidea Madsen, 1950	8	**3**	12	**3**
Luidia heterozona Fisher, 1940	19	**15**	154	**94**
Luidia numidica Koehler, 1911	1	**0**	1	**0**
Centrostephanus longispinus (Philippi, 1845)	8	**7**	13	**14**
BRYOZOANS				
Cupuladria canariensis (Busk, 1859)	9	**5**	31	**10**
Hippoporidra senegambiensis (Carter, 1882)	15	**7**	84	**23**

Annex III. Species collected during the February 1970 cruise on the 45 m depth bottoms off Grand-Bassam (Côte-d'Ivoire), with indication of their occurrence and total abundance in the day (D) and night (N) hauls.

Species	Occurrence D	Occurrence N	Abundance D	Abundance N
CNIDARIANS				
Balanophyllia floridana (Pourtalès, 1871)	1	**0**	3	**0**
Alcyonium altum Tixier-Durivault, 1955	1	**0**	1	**0**
Metalcyonium violaceum (Tixier-Durivault, 1955)	26	**22**	1156	**523**
Bellonella madseni Tixier-Durivault, 1955	26	**22**	322	**343**
POLYCHAETES				
Aphrodita alta Kinberg, 1855	0	**4**	0	**4**
Hermodice carunculata (Pallas, 1766)	4	**0**	8	**0**
CRUSTACEANS				
Squilla cadenati Manning, 1970	4	**22**	4	**186**
Squilla mantis (Linnaeus, 1758)	2	**22**	2	**478**
Solenocera africana Stebbing, 1917	2	**22**	3	**2798**
Sicyonia galeata Holthuis, 1952	14	**22**	25	**542**
Processa borboronica Holthuis, 1951	0	**8**	0	**15**
Parapandalus narval (Fabricius, 1787)	3	**11**	31	**76**
Pontocaris cataphracta (Olivi, 1792)	11	**22**	14	**257**
Scyllarus caparti Holthuis, 1952	26	**22**	273	**4315**
Scyllarus posteli Forest, 1963	26	**22**	1096	**3925**
Stenopus spinosus Risso, 1826	1	**1**	1	**1**
Paguristes mauritanicus Bouvier, 1906	26	**21**	593	**164**
Diogenes pugilator Roux, 1829	3	**0**	3	**0**
Diogenes ovatus Miers, 1881	21	**19**	80	**76**
Dardanus pectinatus (Ortmann, 1892)	5	**5**	6	**5**
Pagurus mbizi Forest, 1955	25	**20**	95	**57**
Pagurus alatus Fabricius, 1775	24	**21**	70	**40**
Pagurus cuanensis Bell, 1846	12	**9**	15	**13**
Pagurus triangularis (Chevreux and Bouvier, 1892)	3	**6**	3	**6**
Raninoides bouvieri Capart, 1951	1	**15**	1	**27**
Sternodromia spinirostris (Miers, 1881)	4	**22**	6	**161**
Homola barbata Fabricius, 1793	5	**8**	5	**10**
Ethusa vossi Manning and Holthuis, 1981	3	**1**	4	**1**
Medorippe lanata (Linnaeus, 1767)	26	**22**	341	**1297**
Calappa pelii Herklots, 1851	21	**6**	52	**9**
Atlantotlos rhombifer Doflein, 1904	3	**1**	3	**1**
Ilia spinosa Miers, 1881	2	**11**	2	**19**
Liocarcinus corrugatus (Pennant, 1777)	1	**7**	1	**10**
Macropipus rugosus (Doflein, 1904)	24	**22**	180	**5427**
Portunus inaequalis (Miers, 1881)	1	**1**	1	**1**
Machaerus oxyacantha (Monod, 1956)	4	**10**	4	**15**
Inachus leptochirus Leach 1817	3	**0**	3	**0**
Capartiella longipes (Capart, 1951)	2	**1**	2	**1**
Macropodia gilsoni (Capart, 1951)	3	**2**	3	**2**
Macropodia spinusola (Miers, 1881)	1	**2**	1	**2**
Stenorhynchus lanceolatus (Brullé, 1837)	3	**6**	3	**7**
Parthenope notialis Manning and Holthuis, 1981	25	**22**	138	**94**
Heterocrypta maltzami Miers, 1881	1	**0**	1	**0**
MOLLUSCS				
Calliostoma hernandezi Salazar and Gubbioli, 1993	8	**10**	11	**13**
Turritella annulata Kiener, 1853	9	**6**	12	**7**
Architectonica nobilis (Röding, 1798)	2	**2**	2	**2**
Xenophora senegalensis Fischer, 1873	7	5	7	10

Annex III. (continued).

Species	Occurrence D	Occurrence N	Abundance D	Abundance N
Natica canariensis Ohdner, 1931	2	0	2	0
Sigaretus bifasciatus Recluz, 1851	0	**1**	0	**1**
Cypraea petitiana Crosse, 1873	2	**1**	2	**1**
Phalium saburon Bruguière, 1792	1	**16**	1	**39**
Distorsio ridens (Reeve, 1884)	12	**16**	16	**23**
Tonna galea Linnaeus, 1758	0	**1**	0	**1**
Murex cornutus Linnaeus, 1758	10	**6**	12	**9**
Murex rosarium Chemnitz, 1788	4	**4**	8	**4**
Murex varius Sowerby, 1834	5	**1**	6	**1**
Trophon fusulus (Brocchi, 1814)	1	**0**	1	**0**
Phos grateloupianus Petit de la Saussaye, 1853	4	**4**	5	**4**
Metula cumingi Adams, 1858	4	**3**	4	**3**
Nassarius turbineus (Gould, 1845)	7	**3**	8	**3**
Lathyrus filosus Schubert and Wagner, 1829	1	**0**	1	**0**
Fusus caparti Adam and Knudsen, 1955	1	**0**	1	**0**
Tudicla afra Gmelin, 1790	17	**15**	26	**15**
Cymbium patulum (Broderip, 1830)	5	**8**	7	**18**
Cancellaria cancellata Linnaeus, 1767	6	**5**	10	**5**
Marginella cincta Kiener, 1834	0	**6**	0	**6**
Clavatula muricata (Lamarck, 1822)	0	**1**	0	**1**
Clavatula diadema Kiener, 1841	22	**15**	51	**32**
Clavatula lelieuri (Recluz, 1851)	13	**9**	18	**11**
Clavatula aculeiformis (Lamarck, 1822)	0	**1**	0	**1**
Turris undatiruga (Bivona, 1832)	2	**2**	2	**2**
Turris consociata (Smith, 1877)	0	**1**	0	**1**
Genota mitraeformis (Wood, 1828)	8	**7**	9	**8**
Terebra corrugata Lamarck, 1822	1	**0**	1	**0**
Philine aperta Linnaeus, 1767	15	**10**	64	**61**
Pleurobranchaea gela Marcus and Marcus, 1966	0	**2**	0	**13**
Fimbria fimbria (Linnaeus, 1767)	0	**1**	0	**1**
Crassatella triquetra Reeve, 1842	4	**5**	4	**5**
Cardita umbonata Sowerby, 1904	1	**0**	1	**0**
ECHINODERMS				
Antedon dubenii Bölsche, 1866	5	**1**	5	**1**
Astropecten irregularis Pennant, 1777	23	**16**	86	**42**
Astropecten jarli Madsen, 1950	2	**0**	2	**0**
Luidia atlantidea Madsen, 1950	1	**0**	1	**0**
Luidia heterozona Fisher, 1940	20	**8**	37	**12**
Luidia aciculata Mortensen, 1933	2	**1**	2	**1**
Centrostephanus longispinus (Philippi, 1845)	3	**5**	3	**8**
Genocidaris maculata A. Agassiz, 1869	3	**3**	3	**3**
Schizaster edwardsi Cotteau, 1889	24	**20**	109	**73**
Rhopalodina gracilis Panning, 1936	1	**0**	1	**0**
BRYOZOANS				
Cupuladria canariensis (Busk, 1859)	22	**20**	89	**89**
Hippoporidra senegambiensis (Carter, 1882)	19	**17**	92	**74**