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Diurnal Activity and Feeding Habits of Plaice

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Introduction.

Various authors mentioned that plaice finds its food animals by vision (Franz, 1910), Petersen & Boysen Jensen (1911), Steven (1930), Creutzberg (1946), Jones (1952)). In accordance herewith, Woodhead (1960) found that the catches of plaice were greater during daylight hours than at night. Laboratory observations showed, however, that plaice is more active at night than during the day (Blegvad, 1916), Harder & Hempel (1954), Kruuk (1960). This seems contradictory. In order to get a better insight in the diurnal activity of plaice, investigations have been carried out covering studies of catch data, observations on feeding, and aquarium experiments.

Diurnal variation in trawl catches.

In the years 1954-58 the Netherlands Sea Fisheries Inspection collected data on the catch per haul of a great number of commercial fishing vessels. For our present purpose only those trips were selected related to fishing in two limited areas viz., area I between 52°00'N and 52°20'N, and 3°00'E and 4°20'E, and area II enclosed by a line drawn from 53°00'N, 03°00'E, northward to 53°40'N, 03°00'E, then NE-ward to 54°40'N, 04°00'E, next eastward to 54°40', 05°40'E, from here southward to 53°40'N, 05°40'E, then SW-ward to 53°00'N, 04°20'E, and westward to 53°00', 03°00'E.

For each trip of at least 24 hours the catch per haul was expressed as percentage of the average catch per haul of that trip. The average relative catch of plaice within each two-hour period has been plotted in Figure 1. (In fact the duration of the hauls was on the average about 3 3/4 hours. The midpoint between the time of shooting and of hauling was estimated and all hauls with the midpoint within a 2 hours period were averaged). All graphs indicate that the catches during daytime are greater than those at night in the period March to October, inclusive. In area I the average catch during night hours is about 75% of the catches made at daylight. For area II this is about 85%. Woodhead (1960) gives a percentage of 69%. In November-December, however, the difference between the day- and night catches disappears gradually, and in January-February the average catches are rather higher at night than during the daylight hours. Since January and February are the months in which spawning takes place, it is not impossible that this phenomenon is in one way or another related with spawning. (Forster (1953) observed that the spawning activity is highest in the early evening). The difference between the diurnal variation in the catches in January-February and in the remainder of the year is greater in area I than in area II, which also indicates a possible effect of spawning, since area I is close to the main spawning area of the southern plaice population.

It should be mentioned that although the average data presented in the graphs demonstrate the described phenomena very clearly, individual observations may show considerable variation, even to such an extent that separate 24 hours' series of hauls may show the reverse of the average picture. It is assumed that this is not due to random variation only, but it has not been possible to demonstrate which factors other than day or night do effect the diurnal variation in the catches.

Diurnal periodicity in feeding

In order to obtain further information on the diurnal periodicity of feeding, intestinal tracts were collected of plaice (25-35 cm long) caught at various hours of day and night (November 1962). The digestive tracts were divided into three parts A) oesophagus and stomach, B) first half of the duodenum, and C) second half of the duodenum and rectum. The contents of each of these three parts were recorded (graded: full, 3/4, 1/2 full, 1/4 full, empty). The food consisted for about 90% of pectinaria and about 5% of *Lanice*.

It appeared that the stomachs had the greatest contents in the early evening hours, whereas they were nearly empty round 3-4 O'clock a.m. (Table 1).

Table 1. Percentage of filling of 3 sections of the intestinal tract of plaice during the night.

Time (mid-point)	Number of observed plaice	A	B	C
20.15 h.	22	63%	79%	79%
22.00 h.	28	58%	50%	55%
23.30 h.	38	68%	67%	67%
1.15 h.	36	18%	51%	86%
3.00 h.	27	8%	53%	92%
4.15 h.	25	3%	32%	76%
6.00 h.	36	32%	58%	79%

From this it can be concluded that the plaice feeds mainly during the day or early evening.

Jones(1952) found that plaice stomachs were nearly empty in the early morning and became gradually fuller during daytime). The plaice started feeding in the early morning when it was still dark (6 o'clock 32%, sunrise 6.55 h.) Stomachs of mature plaice collected in the spawning area in the Southern Bight in the period 29. January - 2. February 1963 led to the same results as those of the November samples, with the only difference that the average quantity of food in the stomachs was about 1/3 of that in November. The observations on the grade of filling of the first and second half (B and C) of the duodenum confirm the conclusion that plaice feeds during daytime (see Table).

#### Laboratory experiments

Some preliminary experiments on the diurnal activity of plaice in aquaria were carried out with the apparatus used by Kruuk (1960). Tiny lead balls were suspended in the aquarium at three different levels viz., near the bottom, in midwater, and near the surface. When a plaice touched one of these balls or their suspension threads, the movement of this thread closed an electric circuit resulting in registration on a kymografion.

The following experiments have been carried out:-

a) Registrations were made of three plaice in an aquarium in reduced daylight (light intensity comparable to that at the sea bottom at about 10 m depth). During daylight the animals did hardly move. After sunset, their activity increased, with maxima around 20 h., 23 h., and 04 h. The plaice then left the bottom regularly and swam in the aquarium. Considerable activity was registered for the two upper levels. After sunrise, the activity decreased quickly and from 8 h. a.m. onward the animals were practical inactive.

b) The same plaice as in the previous experiment were exposed to artificial light (a daylight bulb of 40 Watt above the aquarium) from 13.30 h. - 19.30 h. and from 1.30 h. - 7.30 h. The periods in between they were kept in total darkness. The results were: 1st day, first dark period, 19.30 h. - 1.30 h. great activity, light period 1.30 h. - 7.30 h. no decrease of activity, dark period 7.30 h. - 13.30 h. still great activity, light period 13.30 h. - 19.30 h. no activity.

The 2nd day the same results were obtained as the first day.

The 3rd day the fish are moving in the light period from 13.30 h. - 19.30 h., but are much more active in the dark period 19.30 h. - 1.30 h. Then they regularly leave the bottom for shorter or longer periods. During the light period 1.30 h. - 7.30 h. they are much less active, and in the dark period 7.30 h. - 13.30 h. activity is increased again.

The 4th day gave about the same results as the 3rd day. Apparently an "internal rhythm" governs the daily activity but darkness does stimulate the activity during day-time too. After a few days the activity follows the light-dark pattern with some activity during the light hours too.

c) Using new fish, the ordinary pattern of day and night was given with artificial light from a bulb above the aquarium, giving 10 lumen of diffuse light. During the night the plaice were most active, often leaving the bottom, but during daytime they showed some activity too, moving along the bottom.

### Summary and Conclusions

The observations on commercial catches and on the time of feeding confirmed the findings of previous authors that the average catches of plaice are greater during daylight hours than at night (Woodhead, 1960), (except in the spawning season), and that feeding takes place during daytime (Franz, 1910), (Petersen & Boysen Jensen, 1911), (Creutzberg, 1946), (Jones, 1952). These observations seem to contradict the results of investigations of Blegvad (1916), of Harder & Hempel (1954), and Kruuk (1960), that plaice in aquaria are much more active at night than during the day.

Our observations, though preliminary only, indicated that under ordinary light conditions, the activity in aquaria is very restricted during daylight. Although apparently a kind of "internal clock" regulates this mechanism, it is also influenced by the periodicity in light and dark. After a few days, the fish adapts itself to a change in this periodicity. So far these results are in accordance with the previous findings on the effect of day and night, and leave it difficult to understand that the fish feeds during the daytime. However, experiments with a limited amount of light suggests that under light conditions such as prevail at the sea bottom plaice are active during daylight hours too, moving along the bottom, whereas during the night they may move off the bottom, as has also been observed by Woodhead (1960). It is possible that the rather great light intensity which often is found in aquaria, suppresses the normal behaviour of plaice in these aquaria during the daylight hours.

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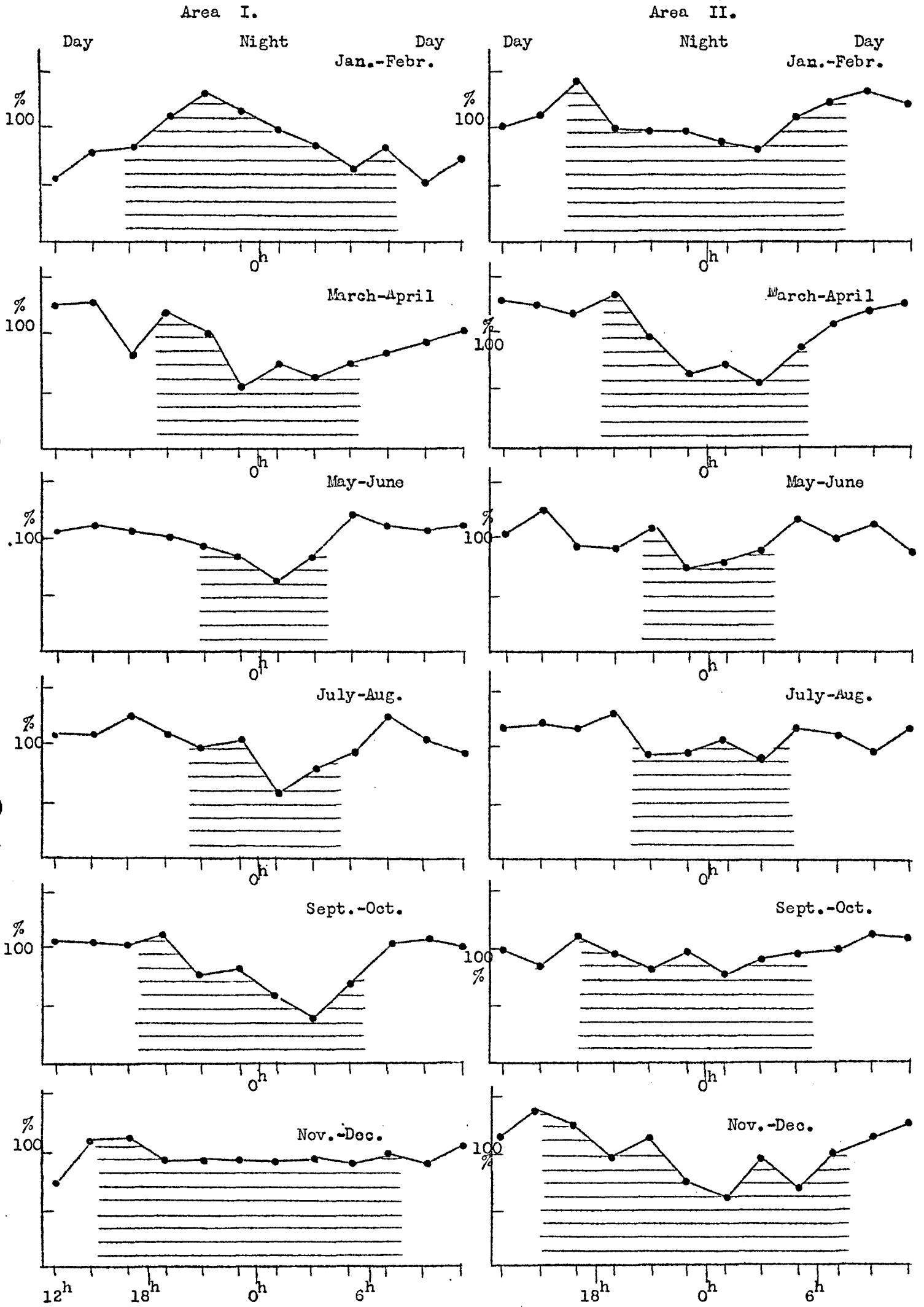


Figure 1.