THE GENERAL REPORT OF THE CAMBRIDGE ZOOLOGICAL EXPEDITION

TO THE RED SEA (JORDAN) 1978

A study of individual recognition in the coral reef fish,
Dascyllus aruanus

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INTRODUCTION

The Cambridge Zoological Expedition to the Red Sea carried out a series of behavioural experiments on a species of coral reef fish, Dascyllus aruanus, in the Red Sea at Aqaba, Jordan, during August and September 1978. The members of the expedition were divers from the Cambridge University Underwater Exploration Group.

Dascyllus aruanus is a Pomacentrid damselfish found throughout the Indo-Pacific Region in shallow coastal waters[1]. The fish live in groups of 3 to 25 individuals centred on a coral head 30 to 50 cm in diameter[1,2] A group usually consists of a male and a harem of females[2] The groups are distinct and the fish stay close to their coral head which they defend against other fish.[1,2,3]

The expedition's project was a detailed study of individual recognition in these fish and of the possible role of sound produced by the fish.

Many bird and mammal species can distinguish between individuals of their own species; this ability often plays an important part in the social behaviour of such animals.[4]

Individual recognition has been little studied in fish which is especially surprising as many species of coral reef fish live in small groups. A German study (Fricke, H.W., 1973, Naturwiss. 60, 204-205)[5] showed that a pair-living damselfish, Amphiprion bicinctus, was able to recognize its partner. Later studies (Fricke, H.W. & Holzberg, S., 1974, Naturwiss. 61, 367-368)[2] suggested that individual recognition might occur in D. aruanus. Unfortunately no details of their methods or results seem to have been published. A further question was whether individual recognition in D. aruanus could occur when the fish were taken from their home coral and placed in a new environment.[6] The expedition's aim was thus to continue and extend the work previously done with D. aruanus.

THE EXPEDITION

The idea of a behavioural study was discussed in October 1977 by a group of final year zoologists who were also members of the Cambridge University branch of the British Sub-Aqua Club, CUUEG. D. aruanus was suggested as a suitable subject for a study of fish behaviour because it is one of the commonest reef fishes, easily identified, lives in shallow water, and parts of its basic biology have already been described.[1,2] By November the expedition had six members including a tape-recording specialist for the recording of fish sounds. Contacts were made in Jordan and many people helped with the planning of the project. A prospectus outlining our project proposals was sent to possible grant-giving bodies. As a result the expedition was funded in part by our own contributions and in part by grants from Colleges, trusts and other organisations. These are acknowledged later in this report, with our thanks to all those who helped the expedition.

At the beginning of August two members of the expedition left for Jordan to complete our diving arrangements. A week later the rest of us arrived in Jordan and within four days diving at Aqaba began.

We stayed at the Al-Samaka, a seafront restaurant and hotel in Aqaba. Each morning the staff from the University of Jordan Marine Science Station took us to the dive site, 10 km south of the town, where a sandy break in the fringing coral reef provided good access. A further advantage of this site was the shade given by a partially completed building on the shore. Apart from this there was no cover; the desert extends to the sea's edge. From the dive site we could see the Israeli city of Elat on the opposite shore of the Gulf of Aqaba.

Most of our work was within 300m of the shore at a depth of 5 to 7m. While deep enough to be unaffected by the swell, this gave us freedom from decompression requirements and resulted in low air consumption - dives of more than 2 hours per tank were common. Near the end of the project we also dived at other sites near the Saudi border. During 25 days of diving, 310 man hours were spent underwater in the completion of 225 man dives.

THE PROJECT

The first week's diving was spent watching undisturbed groups of D. aruanus and developing a technique for capturing the fish, unharmed, by using an anaesthetic.[3]

The first experiments involved observing the response of a group of fish to a D. aruanus presented, near the group's coral, in a large plastic and wire observation cube (0.5 m sides) (Fig. 1). When the fish in the box was a member of that group, and therefore known or 'familiar', it was almost ignored. However, when a 'foreign' D. aruanus, from another group, was presented it was repeatedly attacked, through the plastic, up to 500 times in 15 minutes. This series of experiments was repeated on 8 different D. aruanus groups.

To observe what occurs under more natural conditions when a foreign D. aruanus attempts to join another group a series of 'release' experiments was carried out. A D. aruanus released in open water will swim towards the nearest coral for shelter. It will also swim towards members of its own species so a group of D. aruanus above a coral head is doubly attractive.[7]

Both foreign and familiar D. aruanus swam towards the group when released. The familiar fish was ignored and allowed to return but the foreigner was chased away with headbutting and vocalisation by group members.

These experiments suggest that D. aruanus can recognise whether another D. aruanus is familiar or foreign. It could be that a 'foreign' fish, because it does not recognise the nearby coral, acts in a 'foreign' manner, causing it to be attacked by the group fish. Would D. aruanus recognise familiar and foreign fish when the group was removed from its home coral?

This possibility was investigated by taking two complete groups from their corals, marking the fish from one group by fin-clipping under anaesthesia, mixing them together in a plastic bag, before releasing them into a large observation cube. At either end of this cube we had placedacoral head that neither group had seen before (Fig. 2). For the first few hours the distribution of fish seemed random. However, 24 hours later a pattern emerged: marked fish seemed to stay at one end, unmarked fish at the other. Thus, even away from their home corals, D. aruanus seem to be able to recognise and associate with members of their original group.

Could the separation be due to the fin-clipping; all clipped fish grouping together? For the control experiment the conditions were the same as before except that half the fish from each of the two groups were clipped. Even after 24 hours there was no separation into clipped and not-clipped groupings. The separation seen in the first experiment was not, therefore, likely to be due to the effects of fin-clipping.

D. aruanus, like many damselfish species, can produce chirps loud enough to be heard by a diver up to 1 meter away. The recording of these sounds was the final part of the project. Hydrophones, placed between observation cube and coral, were connected to a portable reel to reel tape recorder on shore. The tape recordings were synchronized with the behavioural observations so that the two may be correlated.

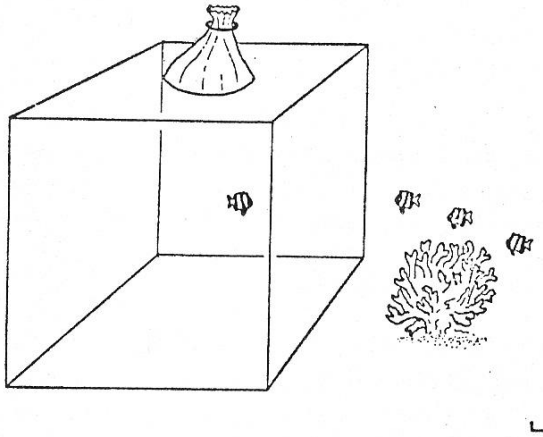

Figure 1. The presentation experiments. A fish, either familiar or foreign, was released inside the clear plastic sided wire cube. The plastic entrance tunnel on top was then kept closed with a rubber band. A diver noted the responses of the group of fish on the coral.
The scale represents 10 cm.

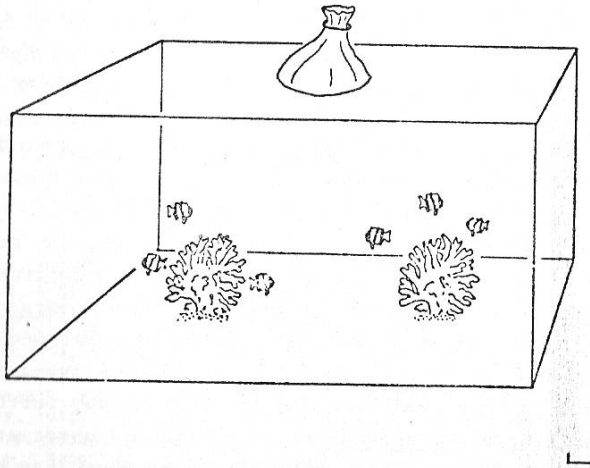

Figure 2. The separation experiments. Two groups of fish were mixed together and then released into the centre of a long wireframe observation cage with clear plastic sides. A piece of coral was placed at each end. A diver noted at minute intervals the positions of the fish inside the observation cage.
The scale represents 10 cm.

When planning the project we had thought that these sounds might be used to distinguish familiar and foreign. However, observation in the field and analysis of our tape recordings seems to suggest that in D. aruanus the chirps and clicks are produced principally by fish when defending their territory. Recognition of familiar and foreign is likely to be by visual cues, possibly by differences in black and white markings, perhaps by movements. The analysis which is in progress, of the sounds themselves will be by computer programs which produce conventional sonographs, 3 dimensional graphs of intensity and frequency against time and digitally filtered waveforms.

Discussion

D. aruanus is a plankton feeder so the coral is probably not used for food but rather for shelter: at night or on the approach of a predator the fish hide among the branches of the coral.[1,3] The number of D. aruanus on a coral head is proportional to coral size, so space is probably limiting.[8,9] In teleological terms, it is thus in a fish's interest to chase away other fish attempting to join the group which would make the coral head more crowded. It would also make sense to be able to distinguish between fellow group members and intruders. Effort is not then wasted in chasing away the former. How the equilibrium is determined is a further question. These suggestions can only be speculative but they may provide some reasons for the existence of individual recognition in a colonial reef fish. This summer's work on D. aruanus may be the first time that individual recognition has been demonstrated with experimental evidence, in a reef fish living in groups. The cues used in this recognition would repay further study. The ability of D. aruanus to recognise and associate with group members, even in a strange environment, has been shown for the first time.

The ability of fish to distinguish own-group and foreign fish of the same species raises the possibility that individual recognition may play a part in the spacing of coral reef fish, a topic of much interest in the ecology of coral reefs.[eg.10]

SUMMARY OF THE PROJECTS

Dascyllus aruanus is a coral reef damselfish that lives in small groups. Experiments carried out by the expedition demonstrated the following:

(i) Within their own species, the fish can distinguish between their fellow group members and foreigners from another group. The foreign fish is attacked and the familiar fish is accepted.

(ii) The ability to recognise other fish as familiar or foreign is not dependent, as was previously thought, on the fish being in their home territories. When two groups are mixed together and released into an environment new to all of them the fish still separate into their two original groups.

(iii) The fish make clicks and chirps when chasing one another. Our results suggest, however, that the role of sound in recognition is doubtful.

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A scientific report, describing the methods and results in more detail, is being prepared. For a copy of the Scientific Report please write to T. Wyatt, Dept. Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, U.K.

MEMBERS

Simon Ciszter,B.A. Natural Sciences (Zoology). Leader
Marek Grabowski, B.A. Natural Sciences (Genetics) Diving Officer
Margo Mclaren, B.A. Natural Sciences (Zoology) Treasurer
Veronica Walford, final year Economics Tripos. Food & Supplies
John Walliker, B.A. Natural Sciences (Physics), Dip. Computer Sciences, Sound engineer and Computer specialis
Tristram Wyatt, B.A. Natural Sciences (Zoology) Scientific Officer

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Mr. G. Katzir, Sub-Dept. Animal Behaviour, Dept.Zoology,Cambridge.
Dr. H.R. Lubbock, Department of Zoology, Cambridge.
Prof. A.A. Myrberg,Jr. Univ. of Miami, Fla., U.S.A.
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Expenditure	£
Air Fares	1044.00
Accommodation in Jordan	259.48
Food	233.91
Scientific Equip.	224.91
Compressed Air	200.17
Transport inJordan	172.40
Administration	128.97
Insurance	168.00
Airport Taxes & Exit Visas	38.94
Expedition Report	36.20
(Entrance)Visas	21.96
Medical Suppls.	16.06
	£2545.00