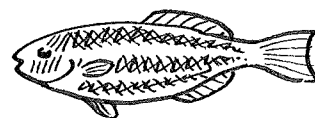


TERRITORIAL RESPONSES OF DAMSELFISHES
(FAMILY POMACENTRIDAE) AGAINST SCHOOLING
COMPETITORS (Scarus croicensis & Acanthurus spp.)



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ABSTRACT

AS A RESULT OF SPACE LIMITATIONS IMPOSED BY TERRITORY-HOLDING DAMSELFISH ON A CORAL REEF, CERTAIN OTHER FISHES SCHOOL AS A STRATEGY TO OVERWHELM DAMSELFISH TERRITORIES AND UTILIZE THE RESOURCES ON THEM. OF PARTICULAR INTEREST ARE THE MIXED SCHOOLS OF STRIPED PARROTFISHES (Scarus croicensis) AND SPECIES OF THE GENUS Acanthurus. THESE TWO GROUPS HAVE BEEN SHOWN TO OVERLAP THE NICHE OF DAMSELFISHES TO DIFFERENT DEGREES. MIXED SCHOOLS WERE STUDIED ON THE WEST BACK REEF OF DISCOVERY BAY, JAMAICA IN ORDER TO FIND IF THE AGGRESSIVENESS OF DAMSELFISH TO THE DIFFERENT FISH IS RELATED TO THEIR NICHE OVERLAP, OR WHETHER THERE IS NO DISTINCTION BETWEEN THEM. THE LATTER IS PROVEN TO BE THE CASE.

Walt:

Good theoretical basis for study
and some good observations
John

INTRODUCTION

SEVERAL ADVANTAGES HAVE BEEN EXPOSED FOR THE SCHOOLING OF FISHES, NOT THE LEAST OF THEM BEING AS A STRATEGY FOR REDUCING PREDATION ON THE SCHOOLING MEMBERS (SHAW, 1978). A FURTHER ADVANTAGE AND PERHAPS ONE OF GREATEST IMPORTANCE ON A CORAL REEF IS THAT OF SCHOOLING AS A MECHANISM FOR CIRCUMVENTING THE TERRITORIALITY OF COMPETITORS (ROBERTSON, et. al., 1976). COMPETITION FOR SPACE ON A CORAL REEF IS FIERCE - THE FISH THAT SEEM TO COME OUT VICTORIOUS MOST OFTEN IN THE SCRAMBLE FOR TERRITORIES ARE THE SEVERAL SPECIES OF PUGNACIOUS DAMSELFISH (Family Pomacentridae). THEIR BIGGEST COMPETITOR IN WESTERN CARIBBEAN WATERS, THE SPECIES WHOSE NICHE OVERLAPS THEIRS THE MOST, IS THE STRIPED PARROTFISH (*Scarus choicensis*), (EBERSOLE, 1977). THESE FISH CAN ALSO BE TERRITORIAL, BUT IN PLACES OF HIGH DAMSELFISH DENSITY THEY TEND TO FORM FORAGING SCHOOLS. IT HAS BEEN SHOWN THAT THESE SCHOOLS ARE MUCH MORE SUCCESSFUL AT FEEDING ON THE ALGAE BEDS WITHIN A DAMSELFISH'S TERRITORY THAN A SOLITARY PARROTFISH WOULD BE, BECAUSE

THEY OVERWHELM THE DAMSELFISH WITH A GREATER NUMBER OF INTRUDERS.

SCHOOLING PARROTFISHES OFTEN HAVE A NUMBER OF OTHER SPECIES THAT ASSOCIATE WITH THEM (ITZKOWITZ, 1974). THE NATURE OF THE ASSOCIATION VARIES FROM SPECIES TO SPECIES. THE MEMBERS OF A HETERO-TYPIC SCHOOL WILL BENEFIT FROM THE ANTI-PREDATOR ADVANTAGES OF THE ASSOCIATION, EVEN MORE SO BECAUSE OF THE GREATER NUMBER OF INDIVIDUALS POSSIBLE. HOWEVER, THE SEPARATE SPECIES HAVE DIFFERENT FEEDING HABITS. SOME ASSOCIATES, SUCH AS GOATFISH (Family Mullidae) POSSIBLY FOLLOW PARROTFISH SCHOOLS IN ORDER TO FEED ON THE INVERTEBRATES THEY STIR UP DURING THEIR VIGOROUS BENTHIC BROWSING (EHRICH, 1975). STILL OTHERS, WHOSE DIETS ALSO OVERLAP TO SOME DEGREE WITH DAMSELFISHES (RANDALL, 1967), BENEFIT, ALONG WITH THE PARROTFISHES, FROM THE STRATEGY OF OVERWHELMING THEIR TERRITORIES. BY FAR THE MOST ABUNDANT OF THESE, AND THE ONES MOST OFTEN ASSOCIATED WITH PARROT-FISH SCHOOLS, ARE THE SURGEON FISHES (Family Acanthuridae).

BASED ON RANDALL'S STOMACH

CONTENT ANALYSES, EVERSOLE HAS FORMULATED RELATIVE INDICES INDICATING DEGREE OF POTENTIAL COMPETITIVE IMPACT OF VARIOUS FISHES WITH DAMSEL-FISHES (PARTICULARLY Eupomacentris leucostictus). ACCORDING TO HIS FORMULA, ADULT STRIPED PARROTFISHES RECEIVE A VALUE OF 22.0, BY FAR THE HIGHEST, WHILE ADULTS OF THE GENUS Acanthurus RECEIVED A VALUE OF 5.7.

WITH THIS IN MIND, I SET FORTH TO FIND WHETHER THE AGONISTIC ACTS BY DAMSELISH TOWARDS THE STRIPED PARROTFISH AND ACANTHURIDS BEAR A COMPARABLE NUMERICAL RELATIONSHIP. THAT IS, WHETHER DAMSELISHES CAN DISTINGUISH BETWEEN THE SPECIES THAT POSE VARYING THREATS TO THEIR FOOD SUPPLY. ON THE OTHER HAND, IT IS POSSIBLE THAT THE NUMBER OF AGONISTIC ACTS ON A SPECIES IN A MIXED SCHOOL IS RELATED TO THE PROPORTION OF THAT SPECIES IN THE SCHOOL.

METHODS

SCHOOLS OF ACANTHURUS AND PARROT-FISH WERE OBSERVED INVADING DAMSEL-FISH TERRITORIES FROM 23 FEBRUARY - 27 FEBRUARY 1981, MOSTLY WITHIN THE WEST BLACK REEF OF DISCOVERY BAY, JAMAICA. HETEROTYPIC SCHOOLS WERE CHOSEN SO THAT FISHES OF THE DIFFERENT SPECIES COULD BE OBSERVED ENTERING THE DAMSELFISH TERRITORIES AT THE SAME TIME. NUMBERS OF AGONISTIC ACTS BY THE DAMSELFISH ON THE SCHOOLING SPECIES WERE RECORDED IN A WATERPROOF NOTEBOOK FOR A GIVEN PERIOD OF OBSERVATIONS. THE LENGTH OF TIME THE FISH WERE OBSERVED WAS LIMITED BY WHEN THEY WERE FIRST FOUND, OF COURSE, AND WHEN THEY SWAM OUT OF SIGHT TOO FAST TO BE KEPT UP WITH, OR WHEN THEY WERE NO LONGER ORGANIZED IN A VIABLE SCHOOL, FOR SOMETIMES THEY WOULD BREAK UP, OFTEN SEGREGATING INTO SMALL MONOTYPIC SCHOOLS.

RESULTS

OVER THE FIVE DAYS, TWENTY-SIX SCHOOLS WITH DIFFERENT COMBINATIONS OF S. croicensis AND Acanthurus WERE OBSERVED FOR SEVERAL MINUTES AT A TIME. THE NUMBERS OF FISH IN THE SCHOOLS AND THE NUMBERS OF DAMSEL-FISH ATTACKS ON THEM IS GIVEN IN TABLE I. IN ORDER TO GIVE THE FREQUENCY OF DAMSELFISH ATTACKS

Acanthurus spp.

S. croicensis

		# FISH IN SCHOOL	# ATTACKS	ATTACKS/min	# FISH IN SCHOOL	# ATTACKS	ATTACKS/min
FEB. 23	1:24 - 1:37 P.M.	10	3	.23	4	1	.08
	1:37 - 1:43	10	0	0	25	2	.33
	1:55 - 2:06	2	0	0	10	6	.67
	2:06 - 2:17	1	0	0	2	4	.44
FEB. 24	9:42 - 9:47 A.M.	2	6	2.0	0	0	0
	1:34 - 1:39 P.M.	1	0	0	4	2	0.4
	1:40 - 1:43	6	0	0	2	3	1.0
	1:44 - 1:46	3	2	1.0	4	5	2.5
	1:46 - 1:52	4	1	.17	4	0	0
	1:53 - 1:54	4	1	1.0	4	2	2.0
	2:00 - 2:04	2	0	0	12	8	2.0
	2:05 - 2:10	20	1	0.2	20	7	1.4
	2:15 - 2:21	5	5	.83	8	4	.67
	2:32 - 2:35	3	0	0	30	7	2.33
FEB. 25	8:43 - 8:51 A.M.	2	3	.38	10	32	4.0
	8:56 - 9:15	5	1	.05	8	40	2.1
	9:21 - 9:24	6	0	0	10	2	.67
	9:25 - 9:30	6	0	0	8	21	4.2
FEB. 26	11:30 - 11:35 A.M.	3	3	0.6	1	2	0.4
	4:26 - 4:40 P.M.	5	5	.36	20	26	1.86
	4:41 - 4:42	4	0	0	8	2	2.0
	4:44 - 4:46	2	0	0	6	2	1.0
	4:50 - 4:51	4	9	9.0	0	0	0
FEB. 27	11:00 - 11:10 A.M.	4	12	1.2	15	26	2.6
	2:11 - 2:17 P.M.	1	4	.67	8	12	2.0
	2:34 - 2:37	4	4	1.33	3	3	1.0

TABLE I. FAW DATA

EQUAL WEIGHT BETWEEN TIME PERIODS, THE NUMBER OF ATTACKS WAS DIVIDED BY NUMBER OF MINUTES INVOLVED FOR EACH PERIOD. TO REVEAL ANY RELATIONSHIP BETWEEN NUMBER OF DDMSELFISH ATTACKS AND THE NUMBER OF FISHES OF DIFFERENT SPECIES IN A SCHOOL, THESE VALUES WERE PLOTTED AGAINST EACH OTHER, SEPARATELY FOR NUMBERS OF S. croicensis AND NUMBERS OF Acanthurus WITHIN EACH SCHOOL (See Fig. 1). THIS RESULT IN A SERIES OF PAIRED POINTS BETWEEN WHICH LINES WERE DRAWN TO SHOW THAT THEY ARE OF THE SAME SCHOOL. MIDWAY BETWEEN EACH PAIR OF POINTS ANOTHER POINT WAS DRAWN, GIVING A FURTHER SERIES OF POINTS THAT WOULD POSSIBLY SHOW ANY RELATIONSHIP BETWEEN SCHOOLS AS A WHOLE. THERE APPEARS TO BE A LINEAR TREND INDICATING NUMERICAL PROPORTIONS ARE IMPORTANT IN THE FREQUENCY OF DDMSELFISH ATTACKS, BUT THE RELATIONSHIP EXPRESSED IN THIS MANNER IS STILL UNCLEAR.

HOWEVER, NOW THAT THE TREND HAS BEEN DETECTED IT CAN BE SHOWN MUCH MORE CLEARLY ON A GRAPH THAT PLOTS PERCENTAGE OF DDMSELFISH ATTACKS ON A CERTAIN SPECIES OUT OF THE WHOLE SCHOOL (Acanthurus in Fig. 2) AGAINST THE PERCENTAGE OF THAT SPECIES IN THE SCHOOL. A REASONABLY DIRECT CORRELATION RESULTS WHOSE LINE HAS THE

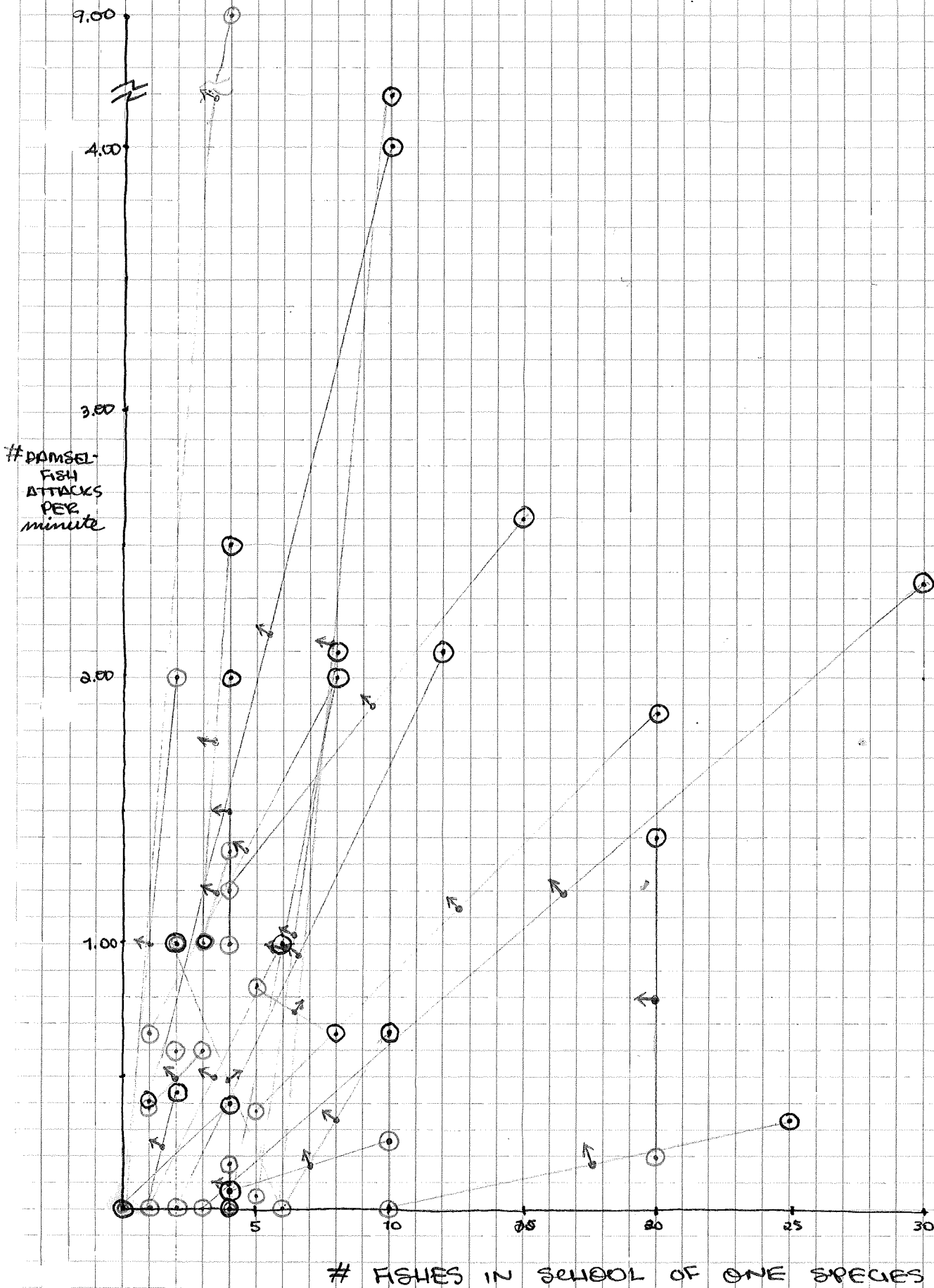


Fig. 1. # FISHES IN SCHOOL VS. THE # DAMSELFISH ATTACKS ON THEM.

%
DAMSEL-
FISH
ATTACKS
ON
ACANTHURIDS

100
90
80
70
60

30
20
10

10 20 30 40 50 60 70 80 90 100

% ACANTHURIDS IN SCHOOL

$$y = .948x - 12.675$$

Fig. 2 THE RELATIONSHIP BETWEEN THE PERCENTAGE OF A TYPE OF FISH IN A SCHOOL AND THE PERCENTAGE OF TOTAL DAMSELFISH ATTACKS ON THAT TYPE OF FISH.

FORMULA OF $y = .948x - 12.675$. IT HAS AN r^2 VALUE OF .486, WHICH TURNS OUT TO BE HIGHLY SIGNIFICANT ($\chi^2_{[27]} = 8.95, p < .001$). THE ERROR CAN BE EXPLAINED AS FOLLOWS; THE LINE WAS DRAWN DOWNWARDS BY THE CASES WHERE THERE WAS A LOW PERCENTAGE OF ACANTHURIDS IN A SCHOOL AND NO DAMSELFISH ATTACKED THEM FOR THE PERIOD OF TIME IT WAS POSSIBLE TO OBSERVE THEM. THEIR LOW PROPORTIONS MADE THEM LESS LIKELY TO BE DETECTED, WHICH IS THE SAME AS SAYING INDIVIDUAL FISH ARE LIKELY TO BE SINGLED OUT WHEN THEY ARE ASSOCIATED WITH LARGER AND LARGER SCHOOLS, THE BASIC ARGUMENT FOR SCHOOLING AS BEING AN ADVANTAGEOUS STRATEGY.

DISCUSSION

THE RESULTS SHOW THAT DAMSELFISH ARE NOT MAKING A DISTINCTION BETWEEN ACANTHURIDS AND STRIPED PARROTFISH IN THEIR AGGRESSIVE ACTS EVEN THOUGH THE TWO VARY IN DEGREE OF NICHE OVERLAP WITH THEM.

BASED ON OTHER OBSERVATIONS INCIDENTAL TO THE STUDY HOWEVER, IT IS OBVIOUS THAT DAMSELFISH ARE MORE OR LESS VIGOROUS IN THEIR ATTACKS ON SOME DIFFERENT SPECIES. FOR EXAMPLE, THEY ARE EXTRAORDINARILY AGGRESSIVE AGAINST BLUEHEAD WRASSES

(*Thalassoma bifasciatum*), which are known egg predators. On the other hand, were not seen chasing spotted goatfish (*Pseudupeneus maculatus*) at all even when they were entering damselfish territories along with parrotfishes and acanthurids. From what is known about their diet they seem to pose no threat to damselfishes.

As far as the striped parrotfishes and acanthurids are concerned, especially the ocean surgeon (*A. bahianus*) and doctorfish (*A. chirurgus*), being all benthic browsers, their foraging habits and method of approach into a damselfish territory are similar, so the damselfish treat them as the same kind of threat. Evolutionarily speaking, it has not been adaptive for the damselfish to have separate responses for these two groups of competitors.

REFERENCES

- EBERSOLE, JOHN P. 1977. "THE ADAPTIVE SIGNIFICANCE OF INTERSPECIFIC TERRITORIALITY IN THE REEF FISH Eupomacentrus leucostictus"
ECOLOGY 58:914-920
- ENRICH, PAUL R. 1975. "THE POPULATION BIOLOGY OF CORAL REEF FISHES"
ANNUAL REVIEW OF ECOLOGY & SYSTEMATICS 6:211-247
- ITZKOWITZ, MURRAY. 1974. "A BEHAVIORAL RECONNAISSANCE OF SOME JAMAICAN REEF FISHES"
ZOOLOG. J. LINN. SOC. 55: 87-118
- RANDALL, J.E. 1967. "FOOD HABITS OF REEF FISHES OF THE WEST INDIES"
STUD. TROP. OCEANOGR. 5:665-847
- ROBERTSON, D.R. et.al. 1976. "SCHOOLING AS A MECHANISM FOR CIRCUMVENTING THE TERRITORIALITY OF COMPETITORS"
ECOLOGY 57: 1208-1220
- SHAW, EVELYN. 1978. "SCHOOLING FISHES"
AMERICAN SCIENTIST 66: 166-174