REPORT ON THE EXPORT OF FISHES AND INVERTEBRATES FOR THE AQUARIUM TRADE FROM CURAÇAO 1972 – 1977

by

H. A. M. de KRUIJF

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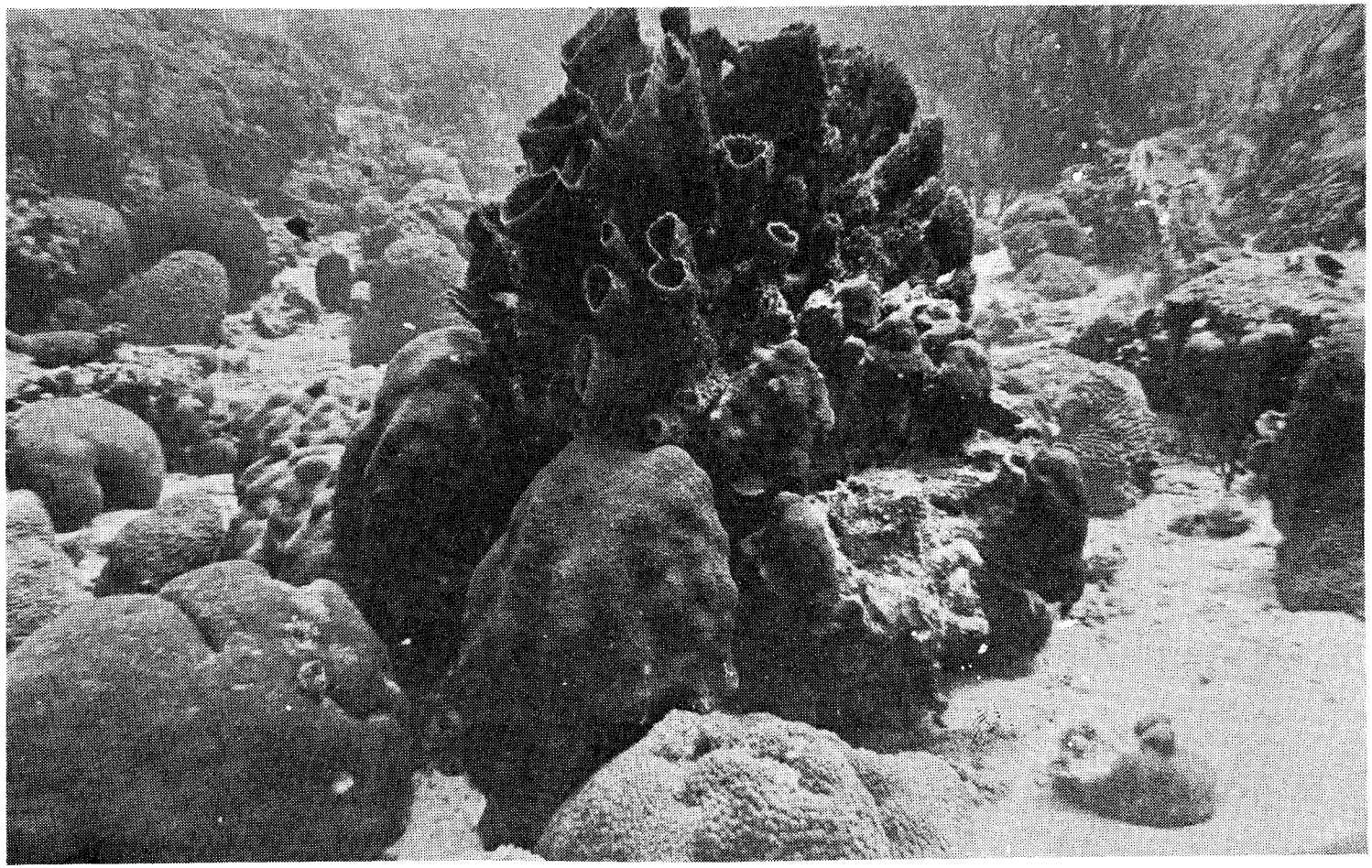

View of shallow part of the reef with sponges on top of a coral.

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The photographs are made by:

Bart de BOER: Gramma loreto (p. 7), Myripristis jacobus (p. 7), Sabella sp. (p. 9), Chaetodon ocellatus (p. 11), Chaetodon striatus (p. 11), Pomacanthus paru (p. 18), Equetus lanceolatus (p. 21), Spirobranchus giganteus (p. 21).

Hans de KRUIJF: View of the reef (p. 2), Stenorhynchus seticornis (p. 9), Condylactis giganteus (p. 10), Diadema antillarum (p. 17), Chaetodon capistratus (p. 18).

INTRODUCTION

In 1970 the Government of the Netherlands Antilles published amendments to an already amended law concerning the export of any goods of archaeological, cultural, and natural value (P.B. 1970, no. 62). Permits could be given for exporting certain items such as fish or plants. Our Institute was entrusted with the control of the export of ornamental fish and invertebrates for the aquarium trade. At that time there were four persons who already exported for this trade and they were licensed. Later on, only two persons were granted permission to export for the aquarium trade. The actual control started in 1971 but due to inexperience of the controlling body actual gathering of the export data began in 1972. Although ultimately six licenses were permitted only three of them exported regularly, the three other exporters making only incidentally use of their license. These three exporters were responsible for over 95% of the trade.

In 1975, Conroy recommended quantifying movement of ornamental fish throughout the world. In view of control measurements and conservation of natural resources this indeed should provide necessary data. If evaluation of export data is necessary it follows that the area of origin of the animals should be known. In this report data on the export of fishes and invertebrates is given for the period 1972-1977. The data nearly exclusively are from Curaçao. The data will be discussed in view of the possible impact on the reef.

METHODS

Each exporter usually has a few divers (with SCUBA apparatus) working at a pay-what-you-collect basis. In the period preceding 1974 collecting was done almost without help of any drug. In some cases this caused extreme damage to the reef, and some areas were severely destructed. Since 1974, nearly all fishes are collected with the drug quinaldine. The divers use squeeze bottles to apply the quinaldine precisely to the individual fish which tries to escape and then is picked up with nets. The fishes from deeper

parts of the reefs are given time to decompress. Next the fishes are taken into tanks with running seawater or in special pans along the seashore. The animals are transported in small plastic bags with seawater and oxygen on top of it. Invertebrates were either collected with nets or simply broken off or removed from the substrate on which they settle. Seaanemones were usually collected in very shallow parts of the reef, mostly in sandy areas. Tubeworms were collected in the inner bays or just below the tidal zone. Spirobranchus giganteus, "live rock", lives on pieces of dead coral or live coral the latter being primarily fire coral, Millepora sp. Until September 1976 stony corals were exported in rather small quantities but since then collecting and handling of corals, dead or alive, is considered a crime according to the law (Afkondigingsblad Curaçao, 1976, no. 48).

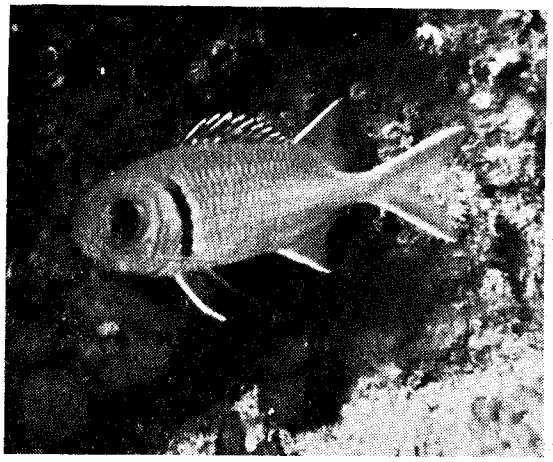
Shortly before the actual transport a precise list of the animals has to be presented to our Institute and checked. Sometimes the actual contents deviated somewhat from the original list due to unexpected losses. The exporters stated that in general only a small percentage of the exported lot does not survive the trip. However, losses in the first stages - collecting, decompressing, storage- might have been considerable but we are unable to estimate even roughly the amount lost.

The value of the exported animals could be estimated only on a very crude base and usually biased. The figures presented here are conservative calculations based on fragmentary information.

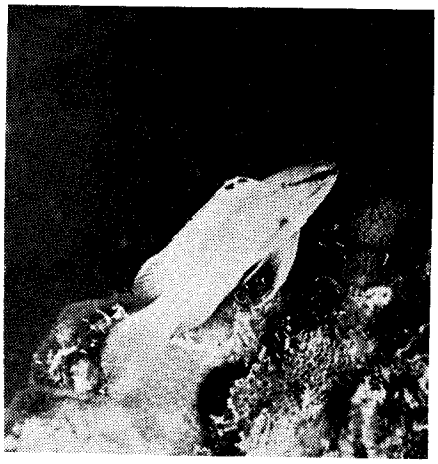
THE EXPORT DATA

The export data are summarized in four tables: Table I, list of species; Table II, yearly export, destination and value; Table III, number of species per year and destination; Table IV, detailed information on the 8 most exported species.

The first table (Table I) includes all species exported within the period 1972-1977, and the total numbers during that period. Clearly, a large proportion of the total export is formed by relatively few species as is also demonstrated in Table IV. There were at least 42 species of fish and many more



Blackbar soldier fish,
Myripristis jacobus



Royal gramma, fairy basslet,
Gramma loreto

Table I. List of species exported for the aquarium trade from Curaçao to the U.S. and Europe during the period 1972-1977. Names of fish are according to Randall (1967), names of invertebrates according to various sources.

Latin name	Common name	total no. exported (1972-1977)
Gymnothorax moringa	Spotted moray	1
Myripristis jacobus	Blackbar soldierfish	13219
Serranids unspec.	Groupers unspec.	13
Serranus baldwini	Red lantern fish	337
- tabacarius	Tobacco fish	372
- tigrinus	Harlequin bass	713
Liopropoma carmabi	Candy basslet	2
- rubre	Swissguard basslet	26
Paranthias furcifer	Creole fish	10
Gramma loreto	Fairy basslet or Royal Gramma	48185
Priacanthus arenatus	Big eye	79
Apogon maculatus	Flame fish	4569
Amblycirrhitus pinos	Hawk fish	77

Table I. continued

Equetus acuminatus	Hi hat	548
- punctatus	Spotted drum	156
- lanceolatus	Jackknife	2632
Opisthognathus aurifrons	Yellowhead jawfish	24244
Chaetodon capistratus	Foureye butterfly	2664
- striatus	Banded butterfly	1283
Prognathodes aculeatus	Longsnout butterfly	2027
Pomacanthus paru	French angelfish	10693
Holacanthus tricolor	Rock beauty	14272
- ciliaris	Queen angel	124
- bermudensis	Blue angel	2
Centropyge argi	Cherubfish	24751
Eupomacentrus planifrons	Yellow damselfish	1010
- leucostictus	Beau gregory	200
- partitus	Bicolor damselfish	1182
Microspathodon chrysurus	Jewelfish	4940
Abudefduf saxatilis	Sergeant major	32
Chromis cyanea	Blue chromis	427
Bodianus rufus	Spanish hogfish	454
Halichoeres garnoti	Yellowhead wrasse	70
Thalassoma bifasciatum	Bluehead	7863
Ophioblennius atlanticus	Red blennie	2196
Gobiosoma species	Neon goby	2267
Acanthurus coeruleus	Yellow tang	493
- chirurgus	Surgeon fish	186
Balistes vetula	Queen triggerfish	1458
Melichthys niger	Black durgon	8
Monacanthus ciliatus	Fringed filefish	70
Canthigaster rostrata	Sharpnose puffer	276
Other species		103

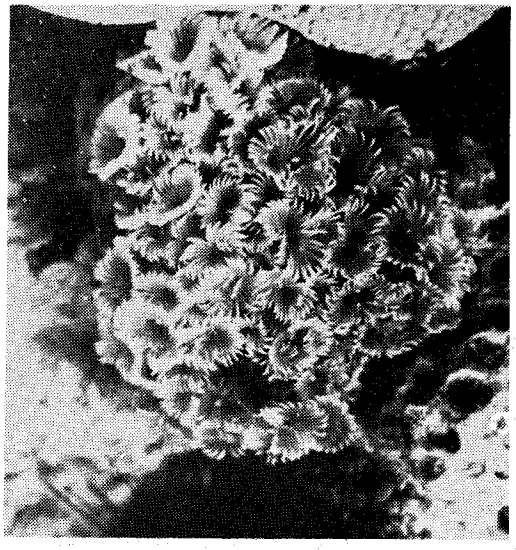
Invertebrates

Condylactis giganteus	Sea anemone 1)	41530
Tubastrea coccinea	Orange coral	4317
Spirobranchus giganteus	Life rock	7862
Sabella sp. (2 species)	Tube worms	34586
Lima scabra	Scallops	7445
Nudibranchs	Slugs	915
Stenopus hispidus a.o.	Cleaning shrimps	3970
Diadema antillarum 2)	Sea urchin	7016
Ophiuridea unspecified	Brittle stars	2288
Crustacea: Decapoda 3)	Crabs (a.o. Arrow and hermit crabs)	3029
Nemaster sp.(Crinoidea)	Sealilies	3
Scleractinia (until Sept. 1976)	Stony corals	822

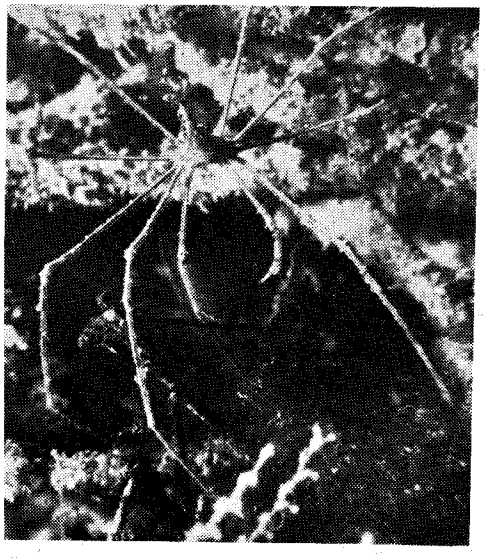
1) A few other species are included here too.

2) Includes also Echinometra lucunter, Eucidaris tribuloides and Tripneustes esculentus.

3) Primarily Stenorhynchus seticornis (arrow crab) and various species of pagurids (hermit crabs).



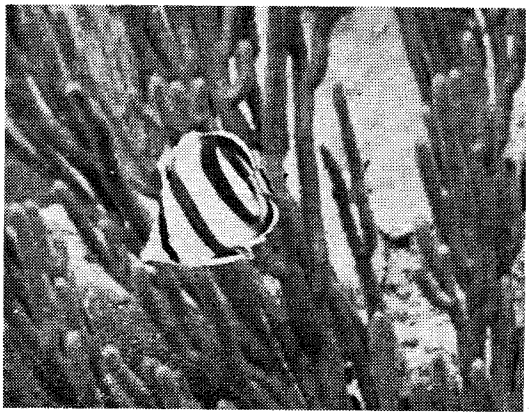
Feather duster, Sabella sp.



Arrow crab, Stenorhynchus seticornis

Seaanemones, Condylactis giganteus

than 15 species of invertebrates. The collectors indicated they collected a few other species of seaanemones in addition to Condylactis giganteus which, however, comprised 95% of the total. The tubeworms were in fact two species, Sabella pavonina and another unidentified species. Apart from Stenopus hispidus, other cleaning shrimps and a few small shrimps associated with sea anemones were exported. In spite of its spiny appearance Diadema antillarum was exported most frequently. Eucidaris tribuloides was only rarely collected and transported. Brittle star lots were assembled from many species. Arrow crabs were most frequently exported, other crabs including hermit crabs only occasionally. Stony coral lots were assembled primarily from brain coral Meandrina meandrites, flower coral, Eusmilia fastigiata, and the solitary and semi-solitary corals, Scolymia lacera and Mussa angulosa.



Banded butterfly,
Chaetodon striatus

Spotfin butterfly,
Chaetodon ocellatus

In the second table (Table II) export figures are presented according to year and destination. The conservative values of the total export are also shown and represent the amount paid by the foreign wholesalers to the local exporters. Except for 1972 the total numbers of animals exported to the USA is rather small compared to the Europe-bound export. In 1975, considered a peak year, the export tripled compared to previous years although the values only doubled. Export in 1976 and 1977 to the USA decreased and is now - June 1978 - nearly nihil. Export to Europe during those years also decreased and the exporters expect a further severe drop in the export. Two causes can be indicated: 1) collectors around Miami are supplying an increasingly larger share of the USA market; 2) the most important cause, however, is opening of the reef areas in Haiti which supplies now the USA market in addition to the Miami production and at extremely low prices. The fear exists that when Haiti gets a direct airtransport connection with Europe, the trade between Curaçao exporters and Europe will probably collapse completely. Haiti can compete because of its much lower labor costs.

The export of invertebrates shows similar trends to the export of fishes. The proportion of invertebrates exported to the USA steadily declined and was only 7% in 1977. The export values increased until the peak in 1975, although the prices

Table II. Export data of fishes and invertebrates per year, and their destination. The last column shows the estimated export values in dollars. These figures are conservative and based on incomplete information. The numbers shown in the column "Total" may be higher than the combined amount of Europe and U.S.A. The destination of several lots were unknown. Destination "Europe" means primarily Western Germany and Holland. There was some export to Italy also.

Year	Fishes			Invertebrates			Estimated
	Europe	U.S.A.	Total	Europe	U.S.A.	Total	values ($)
1972 1)	8597	6164	14836	3939	3103	7042	100.000
1973 1)	14375	2927	18010	4792	1985	7336	125.000
1974	9324	2754	16872	4321	2139	9193	125.000
1975	37130	13816	52624	35145	6281	42102	350.000
1976	25576	10291	35867	22797	3107	25904	250.000
1977	33552	3396	36948	20739	1467	22206	225.000

1) One exporter is not included because he short-circuited the administrative process and did not give us proper information. According to direct information however, he exported rather limited numbers.

Table III. Number of species exported to Europe and the U.S.A.

Year	Fish: # species			Invertebrates: # species		
	Europe	U.S.A.	Total	Europe	U.S.A.	Total
1972	23	26	29	13	6	13
1973	27	22	30	9	7	10
1974	22	19	27	10	6	10
1975	26	13	26	11	4	11
1976	32	13	32	10	8	11
1977	29	15	30	9	5	9

Table IV. Detailed information on the six most exported fishes and the two most exported invertebrates. The figures are broken down to destination and year. Below the row of totals: two percentages are shown: the first is the proportion of all fishes consisting of the 6 species of fish or 2 species of invertebrates; the second percentage shows the proportion of number of species compared to the total number of species exported in the indicated year.

	1972			1973		
Species	Europe	USA	total	Europe	USA	total
Myripristis jacobus	385	300	685	1601	134	1767
Gramma loreto	2353	1922	4307	5391	641	6032
Opisthognathus aurifrons	391	887	1278	1329	329	1658
Pomacanthus paru	1025	418	1446	953	336	1289
Holacanthus tricolor	1048	665	1729	1076	331	1575
Centropyge argi	1140	732	1896	1136	388	1618
Total	6342	4924	11341	11486	2059	13939
% of total of all fishes	74%	80	76	80	70	77
Percentage of species no. %	26%	23	21	22	27	20
Condylactis gigantea	2166	1723	3889	1950	1029	3257
Sabella sp. (2 species)	850	1165	2015	1764	576	2515
% of total of all invertebrates	77	93	84	78	81	79
% of species no.	15	33	15	22	29	20

Table IV continued

	1974			1975		
Species	Europe	USA	total	Europe	USA	total
Myripristis jacobus	548	255	1193	2002	4500	6606
Gramma loreto	2782	948	5102	8405	4310	13217
Opisthognathus aurifrons	742	384	1836	6580	402	7328
Pomacanthus paru	314	69	1254	2794	156	3085
Holacanthus tricolor	665	174	1280	3042	264	3380
Centropyge argi	1026	321	1723	5112	3954	9300
Total	6077	2151	12488	27935	13586	42916
% of total of all fishes	65	78	74	75	98	82
Percentage of species no. %	27	32	22	23	46	23
Condylactis giganteus	1331	938	3624	10302	1226	11895
Sabella sp. (2 species)	894	671	2235	8138	3742	11927
% of total of all invertebrates	51	75	64	53	79	57
% of species no.	20	33	20	18	50	18

Table IV continued

	1976			1977		
Species	Europe	USA	total	Europe	USA	total
Myripristis jacobus	1105	1130	2235	590	80	670
Gramma loreto	8360	1738	10098	8510	920	9430
Opisthognathus aurifrons	5314	487	5801	5817	526	6343
Pomacanthus paru	1880	122	2002	2533	81	2614
Holacanthus tricolor	3051	125	3176	3097	35	3132
Centropyge argi	3622	1349	4971	4466	777	5243
Total	23332	4951	28283	25013	2419	27432
% of total of all fishes	91	48	79	75	71	74
Percentage of species no. %	19	46	19	21	40	20
Condylactis giganteus	9428	750	10178	8632	155	8787
Sabella sp. (2 species)	6842	1475	8317	6805	772	7577
% of total of all invertebrates	71	72	71	74	63	74
% of species no.	20	25	18	22	40	22

per animal apparently dropped. As these prices per individual continue to fall due to competition the export values in the coming years will decline more and more.

Due to the competition between collectors from the various areas in the Caribbean another difference between the market in the U.S.A. and Europe exists from the standpoint of the exporters, weakening furthermore the position of the local sellers. The USA market is apparently interested only in a few species - fishes as well as invertebrates - whereas in Europe there is a demand for a greater assortment. The limited interest in the USA may again be caused by price difference and not necessarily reflects a limited interest of the consumers.

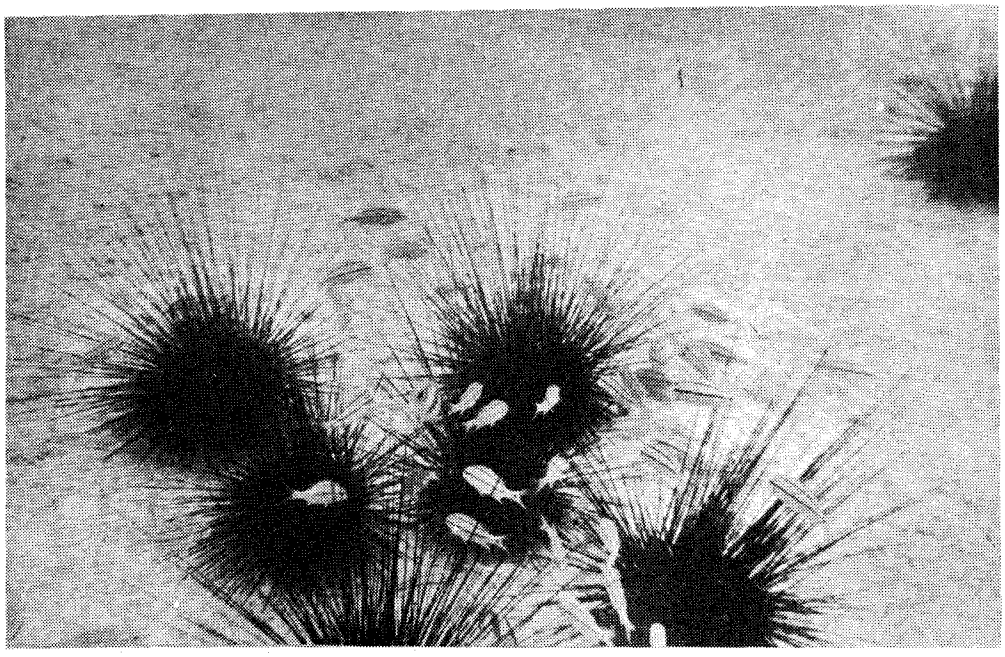
Some species of fish and invertebrates are more in demand than other species. Table IV presents detailed export figures on six species of fish which comprise only about one fourth or one fifth of the total number of exported species but are responsible for more than three quarters of the total bulk. The demand for the black bar soldier fish, Myripristis jacobus, is more variable than the other fish species. Obviously, the fairy basslet or royal gramma, Gramma loreto, is the species most in demand. Interest in the other four species has been relatively stable although the cherubfish, Centropyge argi, is a high-priced species also and therefore is exported in large numbers too.

Only two species form the bulk of all invertebrates exported except during 1974 and 1975 when there was some demand for live rock, i.e. Spirobranchus giganteus. A declining demand in the USA for the invertebrates, already demonstrated in table II, can be seen in this table too.

DISCUSSION

The Trade

The data presented in Table I-IV show that the USA market is much more selective in its demand than the European market. As is suggested earlier the cause should be found in the already present competition. The decline in the export to the USA noticeable after 1975 is expected to come to a virtual standstill in 1978. The USA market has discovered the rich and very cheap source

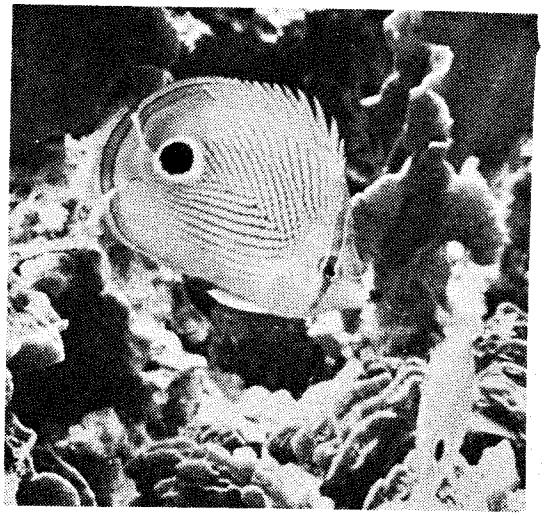


Sea urchins, Diadema antillarum

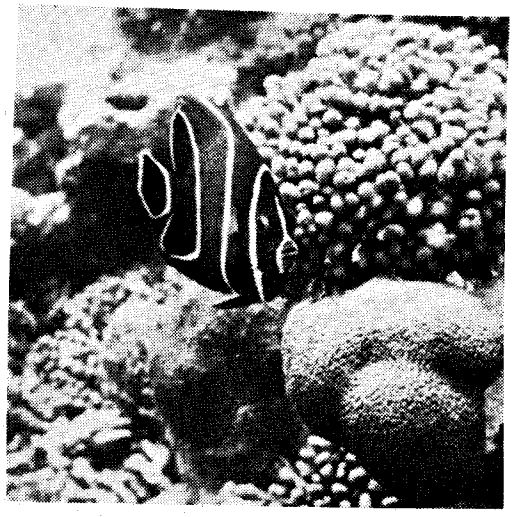
of reef animals in Haiti. At present there is already some export from Haiti via Miami to Europe delivering animals at competitive prices. It is to be expected that the trade in seawater aquarium animals from Curaçao will collapse as soon as any direct transportation between Haiti and Europe is installed.

The animals

We have been very much interested in the effects of collecting fish on the population densities of particular species especially as the numbers of exported fishes seemed to reach alarming proportions. We therefore initiated a study on the effects of collecting Gramma loreto, the most exported species. In this study (de Kruijf et al., 1978) we monitored several aggregations of this species for about a year. In one aggregation we collected only once and caught about 30 to 40% of the resident population. Recovery of the population density



Foureye butterfly,
Chaetodon capistratus



French angelfish,
Pomacanthus paru

was achieved in about four weeks. In another aggregation we collected several times, each time taking roughly 30 - 40% of the population. The time to complete recovery of the density depended completely on the presence or absence of recruits, i.e. juveniles looking for a place to settle within the aggregation. If many recruits were present recovery was completed within just over one week, if less were present it could take several weeks. With great effort a third aggregation was completely removed. To achieve this it was necessary to capture about 450 animals whereas the initial number of individuals present was only about 95. Recovery was completed within 30 days. During the absence of G. loreto the shelterholes and territories were not challenged by other species. These and additional data showed that collecting this species during the reproductive period is not necessarily harmful. Although conclusive evidence still lacks we suggest that collecting G. loreto should be done only during the reproduction season. In addition the number taken from an aggregation should not exceed 30 - 40%. When the number of juveniles declines at the end of the reproduction period, collecting should either be stopped completely or limited to a very low percentage of the resi-

dent population. This study emphasizes the importance to gain knowledge of the reproductive seasons of many of the important species, at least with respect to export.

No exact data on the population ecology of the yellowhead jawfish, Opisthognathus aurifrons, exist although some particulars are widely known among fishermen. This species shows a peak abundance twice a year - around April-May-June and September-October - due to influx of many juveniles. During the periods in between but especially between October and April it is very difficult to find this species in the shallower areas. There are suggestions that they migrate to deeper parts of the reef, but until proven differently we are convinced that predation and maybe collection are largely causing the disappearance during part of the year. This species certainly needs a closer study. The other four species, Myripristis jacobus, Holacanthus tricolor, Pomacanthus paru, and Centropyge argi all have a more or less seasonlike influx of juveniles. However, whereas M. jacobus, C. argi, O. aurifrons, and G. loreto occur in aggregations and individuals do not usually migrate: the angelfishes roam around over large areas of the reef, and certainly occur in lower numbers. As is shown in the next paragraph the number of these species collected for the trade forms a much higher percentage of the total population.

Sea anemones and tube worms were not collected from the reef itself but from adjacent, large, barren areas or from inner bays, where in particular the tube worms grow in large numbers. The number of Condylactis giganteus to be collected from the coral reef itself should be kept at low levels. It is a much more tedious task to collect them in the holes and crevices in the reefs than in the shallow areas and the supply in those areas appears to be much greater than the demand. The tube worms (Sabella sp.) occur in very large numbers in inner bays and entrances to these bays, but are rarely collected in the reef areas. Spirobranchus giganteus, "live rock", grows on live and dead corals. Collecting these can only be done from the reef area, and in reality this means that small destruction actions are carried out. Since the enforcement of the prohib-

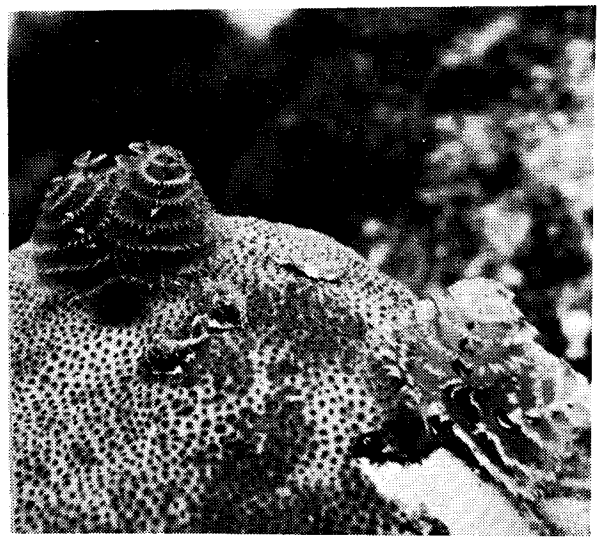
ition law on corals (September 1976) the export of "live rock" is declining also.

The coral reef

The export data suggest a heavy toll from the reef population but the actual impact is difficult to assess. However, I made some calculations to obtain at least some idea of the size of the collections relative to the size of the habitat. Nearly all collecting was done on the reefs along the South West coast of Curaçao. The length of that coast and of the reefs is approximately 75 km. The width of the reefs in the shallow areas is around 50-400 m with an average of about 125 m, in the deeper areas below the drop-off the width is 60-80 m (50 m depth limit). The collectors together certainly do not collect from an area over 25 km. The actual export data are lower than the number of fish collected as there are always losses between catching and transport. We have estimated this loss at 25% although in practice it might be considerably higher. In Table V the numbers of fish are shown, collected per unit area over 25 km of reef. The other 50 km of reef remains untouched. The figures are taken from the year with the highest export figures, 1975.

Four of the species live in aggregations and occur abundantly along the reefs. However, the two Angelfishes, Pomacanthus paru and Holacanthus tricolor, have been collected at a rate of 0.4-1.1 fish per 1000 m^2. Only on P. paru we have some data on population densities in one of the coral reef areas of Curaçao (Post, 1974). This species occurs at a density of about 0.1 fish per 1000 m^2 in those parts which may be considered representative for the reefs along the SW coast. This is obviously lower than the numbers collected per area of similar size. The rock beauty, Holacanthus tricolor, may occur in somewhat higher frequencies than P. paru, but here too the number of collected fishes surpass the number of actually present fishes in similar sized areas. We are therefore convinced that collection of these fishes has reached its limits and thus that export should be limited.

Jackknife,
Equetus lanceolatus



Live rock
Spirobranchus giganteus

The impact of collecting sea anemones, tube worms, and other invertebrates on the reef is rather difficult to estimate. Most of the collected animals occur abundantly in specific areas in the shallow parts of the reefs. There is one invertebrate species for which we are convinced that collecting in huge numbers might even benefit the reefs. This is Diadema antillarum, the spiny sea urchin which on many places occur in densities over 100 per 1000 m^2. Bak and van Eys (1976) showed that this species may even form a threat to the living corals when they occur in such huge numbers.

Help in Conservation of the Reefs

In a way the coral reef and its conservation could benefit from the experience of the professional collectors and their frequent visits to many parts of the reefs. They can easily detect illegal spearfishing and collecting of corals and shells and warn the authorities. Several times this has already happened and they also notified us of several pollution cases. It may well be worthwhile to formalize this situation.

Table V. The number of six species of fish exported in 1975 in relation to the reef surface. Calculations are made as follows: 1, the exported lots are increased by 25% to allow for losses between capture and transport. 2. Length of the reef along the South West Coast is around 75 km. Only 25 km is actually used for collecting of material. Width of shallow areas is from 50 - 400 m (average around 125 m), width of the deeper areas between 60 and 80 m. Total reef surface over 25 km is 25000 x 150 and 25000 x 400 (no extremes included). The unit area is 1000 m^2.

Species	# individuals exported in 1975	Same plus 25%	# of fishes collected per 1000 m^2
Myripristis jacobus	6606	8257	0.8-2.2
Gramma loreto	13217	16521	1.7-4.4
Opisthognathus aurifrons	7328	9160	0.9-2.4
Pomacanthus paru	3085	3856	0.4-1.1
Holacanthus tricolor	3380	4225	0.4-1.1
Centropyge argi	9300	11625	1.2-3.1

CONCLUSIONS

1. The export of coral reef fishes and invertebrates for the aquarium trade has seen peak numbers and values in 1975. Since then the export to the U.S. market is declining and is expected to come to a full standstill in 1978. Export to Europe shows signs of decrease also but may continue to be of some importance in the next few years. Due to the stiff and expanding competition from Miami collectors and Haitian exporters ultimately we expect a continually decreasing export of fishes and invertebrates for the aquarium trade.

2. During the period 1972-1977 the following species were exported in greatest numbers: Gramma loreto was exported most, followed by Centropyge argi, Opisthognathus aurifrons, Holacanthus tricolor, Myripristis jacobus, and Pomacanthus paru. In total 42 species of fish were exported.
   In order of frequency the most exported invertebrates were: Condylactis giganteus, two species of Sabella, Spirobranchus giganteus, Lima scabra and Diadema antillarum. In total well over 15 invertebrate species were exported.

3. Differences in species composition of the exports to the US market and the European market and trends in the export quantities were discussed and may be attributed to the growing competition from other areas.

4. The impact of collecting animals for the aquarium trade on the coral reefs is discussed. While acknowledging the fact that in the earlier period until 1974, serious damage has been done by the collectors due to use of crude methods, at present these methods have been strongly improved thus minimizing the damage. It is demonstrated that species living in aggregations are not collected in such large numbers that they could seriously influence the population dynamics of these species. On the other hand the two Angelfishes, Holacanthus tricolor and Pomacanthus paru are thought to need some collecting limits.

5. Apart from measurements of the impact of collecting on the coral reef there should be some studies on population densities and distribution of the most exported reef fishes and some of the invertebrates.

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