'Quick scan' to assess the prevalence of dermal parasites among coral reef fishes of Bonaire.

Martin de Graaf and Fernando Simal

IMARES C055/15

IMARES Wageningen UR

(IMARES - Institute for Marine Resources & Ecosystem Studies)

Client:	Ir. A.H.M. Schutjes Ministerie van Economische Zaken P.O. Box 20401, 2500 EK Den Haag
	BO-11-019.02-000 IMARES
Publication date:	1 April 2015

IMARES vision:

- 'To explore the potential of marine nature to improve the quality of life'.

IMARES mission:

- To conduct research with the aim of acquiring knowledge and offering advice on the sustainable management and use of marine and coastal areas.

IMARES is:

- An independent, leading scientific research institute.

Recommended format for purposes of citation: de Graaf, M., Simal, F. (2015). 'Quick scan' to assess the prevalence of dermal parasites among coral reef fishes of Bonaire. IMARES Report C055/15, pp. 13

P.O. Box 68
1970 AB IJmuiden
Phone: +31 (0)317 48 09 00
Fax: +31 (0)317 48 73 26
E-Mail: imares@wur.nl
www.imares.wur.nl

P.O. Box 77
4400 AB Yerseke
Phone: +31 (0)317 48 09 00
Fax: +31 (0)317 48 73 59
E-Mail: imares@wur.nl
www.imares.wur.nl

P.O. Box 57
1780 AB Den Helder
Phone: +31 (0)317 48 09 00
Fax: +31 (0)223 63 06 87
E-Mail: imares@wur.nl
www.imares.wur.nl

P.O. Box 167
1790 AD Den Burg Texel
Phone: +31 (0)317 48 09 00
Fax: +31 (0)317 48 73 62
E-Mail: imares@wur.nl
www.imares.wur.nl

Contents

1. Introduction

In the past, diseases and infections have had dramatic impacts on Caribbean coral reef ecosystems (e.g. white band disease in corals (Pantos and Bythell, 2006); mass mortality of the sea urchin *Diadema* (Lessions, 2005)). Regular monitoring of reef organisms for signs of disease and infections may be important as an "early warning system" to possibly prevent devastating outbreaks.

Figure 1.1 *A princess parrotfish (Scarus taeniopterus) heavily infected with dermal parasites (Salt Pier, Bonaire, September 2013; photo's M. de Graaf.*

In September 2013 an unusual number of reef fish species (e.g. Scaridae (Fig. 1.1 , Acanthuridae and Pomacanthidae) infected with dermal parasites were observed during a dive at Salt Pier (M. de Graaf, pers. obs.). In September 2014 one princess parrotfish infected with dermal parasites was dissected and internal and external samples were send to the Central Veterinairy Institute (CVO) in Lelystad (Netherlands) for further histopathological examination. According to CVO the parrotfish suffered from a microspore parasitic infection of the skin, muscles and digestive tract. The cysts caused fibrotic abscesses and necrosis on the fins.

Similar dermal parasites were observed in a recent survey of coral reef fishes on Curaçao and the observed external blemishes were associated with infections by trematodes (digenean metacercaria), turbellarians and protozoans (*Cryptocaryon*) (Bernal et al., 2015). Bernal et al. (2015) reported that infection rates of coral reef fish on Curacao were almost ten times higher compared to infection rates of coral reef fish surveyed in Mexico and Belize. To date, only anecdotal observations exist of parasite infections on coral reef fish on Bonaire but no quantitative assessment of the prevalence of dermal parasites is available.

The objective of the Helpdeskvraag was to:

1) conduct a "quick scan" to determine the current prevalence of dermal parasites among the coral reef fish of Bonaire, and
2) advise EZ on possible consequences and future actions depending on the outcome of the "quick scan".

2. Materials and Methods

Figure 2.1 *Location of the study sites on Bonaire.*

On Bonaire visual surveys were conducted at 17 different sites (Fig. 2.1) between 7 and 16 March 2015. The selection of sites was largely based on the water quality study of Slijkerman et al. (2014), resulting in a selection of sites known to vary in water quality (e.g. City-Salt locations versus northern locations). Some sites were added to the 'quick scan' as a reference based on assumed good water quality (e.g. east coast with minimal human influence) or as additional sites potential eutrophic sites based on the presence of deep-water cyanobacterial mats (Salt Pier and Windsock; Becking & Meesters, 2014).

In general, the reef system on the west coast begins at the waterline and gently slopes down to 10 m depth from where the reef steeply drops to 30-40m (Bak, 1977). The study sites were located on the shallow plateau (back reef) between 1-5 m depth and at the top of the drop off between 10-15 m depth. Two divers swam (3-5m distance between the divers) for 30 minutes parallel to the coast at each of the two reef zones. During each survey both observers recorded the presence or absence of dermal parasites on 41 selected common reef fish species belonging to 16 families (see Table 3.1). For highly abundant species like brown chromis the presence of dermal parasites was recorded for a maximum of 50-75 individuals recorded in each reef zone.

On the east coast the back reef at Lac Kai was surveyed by snorkel while the drop off reef zone was surveyed by SCUBA. Result of the 'quick scan' will be simply presented as infection rates per species, reef zone and/or geographical location.

3. Results, Discussion and Recommendations

3.1 Infection rate per species

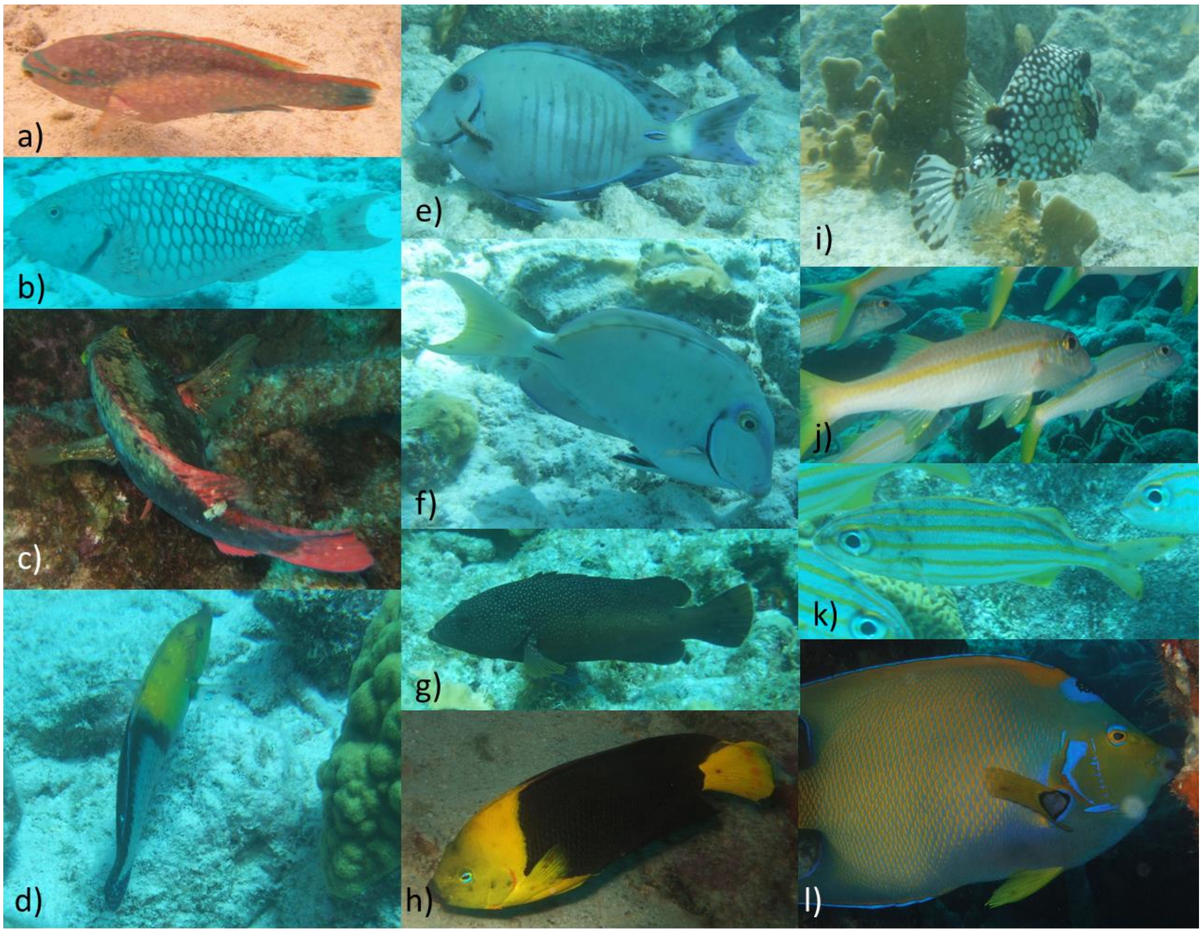

Figure 3.1 *Examples of coral reef fish species infected with dermal parasites on Bonaire: a)* Scarus taeniopterus *(princess parrotfish), b)* Sparisoma viride *(stoplight parrotfish), c)* Sparisoma aurofrenatum *(redband parrotfish), d)* Halichoeres garnoti *(yellowhead wrasse), e)* Acanthurus chirurgus *(doctorfish), f)* Acanthurus tractus *(ocean surgeonfish), g)* Cephalopholis fulva *(coney) , h)* Holacanthus tricolor *(rock beauty), i)* Lactophrys triqueter *(smooth trunkfish), j)* Mulloidichthys martinicus *(yellow goatfish) , k)* Haemulon chrysargyreum *(smallmouth grunt) and l)* Holacanthus ciliaris *(queen angelfish). Photo's by Martin de Graaf.*

In total 16040 coral reef fish were visually inspected for the presence of dermal parasites. Dermal parasites were absent on five of the 41 selected species (Table 3.1) in the survey. In comparison, zero of the 110 species in Mexico, one of the 79 species in Belize and 14 of the 96 species in Curaçao were reported to be infected with dermal parasites (Berbal et al., 2015).

On Bonaire the species with the highest infection rates were *A. tractus* (57%), *C. pullus* (54%), *L. triqueter* (50%), *S. aurofrenatum* (46%), *C. macrocerus* (36%), *A. polygonia* (34%), *A. chirurgus* (32%), *C. fulva* (31%) and *S. taeniopterus* (30%). In addition to the 41 selected species, dermal parasites were also observed incidentally on the sand tile fish (*Malacanthus plumieri*), palometa (*Trachinotus goodei*), sharpnose pufferfish (*Canthigaster rostrata*) and spotfin butterflyfish (*Chaetodon ocellatus*).Not only was the number of infected coral reef fish species on Bonaire considerably higher than on Curaçao, Belize and Mexico but also the proportion of infected individuals for nearly all species was markedly higher on Bonaire than on Curaçao (Table 3.2).

Table 3.1 *Overview of observed dermal parasites infection rates among 41 species (16 families) of coral reef fish on Bonaire.*

Species	Total (#)	Infected (#)	Infected (%)	Species	Total (#)	Infected (#)	Infected (%)
Acanthuridae				**Mullidae**			
Acanthurus coeruleus (blue tang)	955	94	10	*Mulloidichthys martinicus* (yellow goatfish)	1388	262	19
Acanthurus chirurgus (doctorfish)	185	59	32	**Ostraciidae**			
Acanthurus tractus (ocean surgeonfish)	1266	720	57	*Acanthostracio polygionia* (honeycombed cowfish)	32	11	34
Aulostomidae				*Lactophrys triqueter* (smooth trunkfish)	165	83	50
Aulostomus maculatus (Atlantic trumpetfish)	137	16	12	**Pomacentridae**			
Carangidae				*Stegastus partitus* (bicolor damselfish)	568	6	1
Caranx ruber (bar jack)	231	40	17	*Chromis cyanea* (blue chromis)	737	17	2
Chaetodonthidae				*Chromis multilineata* (brown chromis)	1584	5	0
Cheatodon striatus (banded butterflyfish)	127	3	2	*Abudefduf saxatilis* (sergeant major)	516	35	7
Cheatodon capistratus (foureye butterflyfish)	281	1	0	*Microspathodon chrysurus* (yellowtail damsel)	146	2	1
Haemulidae				**Pomacanthidae**			
Haemulon flavolineatum (French grunt)	683	4	1	*Pomacanthus paru* (French angelfish)	68	0	0
Haemulon chrysargyreum (smallmouth grunt)	1041	148	14	*Holacanthus ciliaris* (queen angelfish)	18	5	28
Holocentridae				*Holacanthus tricolor* (rock beauty)	68	14	21
Myripristis jacobus (blackbar soldierfish)	391	20	5	**Scaridae**			
Holocentrus adscensionis (squirrelfish)	146	0	0	*Scarus taeniopterus* (princess parrotfish)	872	258	30
Labridae				*Scarus vetula* (queen parrotfish)	484	36	7
Thalassoma bifasciatum (bluehead wrasse male)	178	2	1	*Scarus iseri* (striped parrotfish)	223	12	5
Clepticus parrae (creole wrasse)	465	7	2	*Sparisoma aurofrenatum* (redband parrotfish)	575	263	46
Halichoeres radiatus (puddingwife)	46	12	26	*Sparisoma viride* (stoplight parrotfish)	707	58	8
Bodianus rufus (Spanish hogfish)	124	21	17	*Sparisoma chrysopterum* (redtail parrotfish)	119	12	10
Halichoeres garnoti (yellowhead wrasse male)	110	7	6	*Sparisoma rubripinne* (yellowtail parrotfish)	156	19	12
Lutjanidae				**Serranida**			
Lutjanus mahogoni (mahogany_snapper)	265	6	2	*Paranthias furcifer* (creole fish)	151	14	9
Lutjanus apodus (schoolmaster)	353	5	1	**Serranidae**			
Monacanthidae				*Cephalopholis fulva* (coney)	167	52	31
Cantherhines pullus (orangespotted filefish)	24	13	54	*Cephalopholis cruentata* (grasby)	200	0	0
Cantherhines macrocerus (whitespotted filefish)	88	32	36				

Table 3.2 *Observed dermal parasites infection rates among 13 species of coral reef fish on Bonaire and Curaçao (Bernal et al., 2015).*

	Bonaire			Curacao		
Species	**Total (#)**	**Infected (#)**	**Infected (%)**	**Total (#)**	**Infected (#)**	**Infected (%)**
Acanthurus coeruleus (blue tang)	955	94	**10**	241	17	**7**
Acanthurus chirurgus (doctorfish)	185	59	**32**	52	6	**12**
Acanthurus tractus (ocean surgeonfish)	1266	720	**57**	147	29	**20**
Caranx ruber (bar jack)	231	40	**17**	17	3	**18**
Haemulon chrysargyreum (smallmouth grunt)	1041	148	**14**	151	2	**1**
Halichoeres garnoti (yellowhead wrasse male)	110	7	**6**	266	2	**1**
Lutjanus apodus (schoolmaster)	353	5	**1**	36	1	**3**
Cantherhines pullus (orangespotted filefish)	24	13	**54**	11	2	**18**
Mulloidichthys martinicus (yellow goatfish)	1388	262	**19**	27	6	**2**
Lactophrys triqueter (smooth trunkfish)	165	83	**50**	20	1	**5**
Sparisoma viride (stoplight parrotfish)	707	58	**8**	221	1	**0.5**
Scarus iseri (striped parrotfish)	223	12	**5**	224	2	**1**
Sparisoma rubripinne (yellowtail parrotfish)	156	19	**12**	13	1	**8**

3.2 Infection rate: spatial variation

Based on this 'quick scan'study, infection rates of dermal parasites seem to be different in the two reef zones (Fig. 3.2, left). The percentage of infected individuals of four abundant reef fish species and 'all fish pooled' appeared to be higher on the shallow back reef compared to the drop-off zone. A similar result was reported by Grutter (1998) for the blackedge thicklip wrasse, where infection rates were much higher on the shallow reef flat compared to the deeper reef slopes due to a higher abundance of parasitic (monogenean) eggs on reef flats.

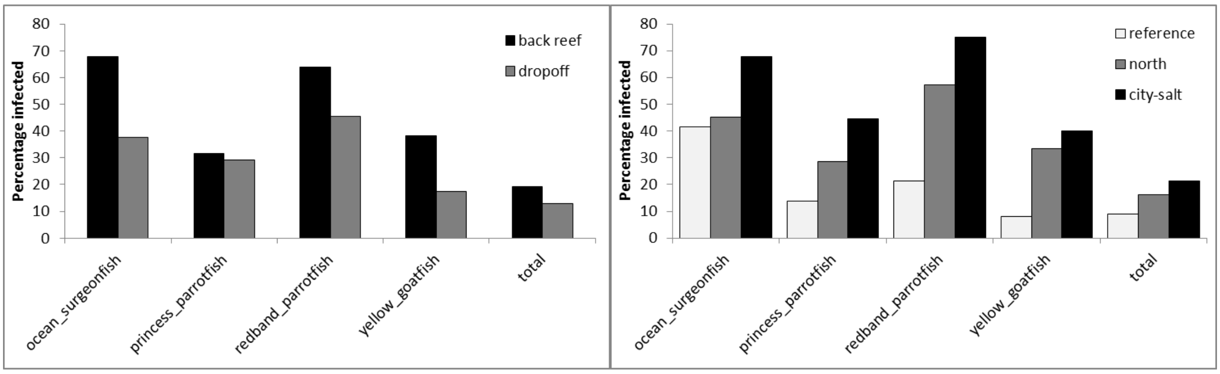

Figure 3.2 *Trends in infection rates between reef zones (left graph) and among geographical areas (right graph).*

In addition, infection rates of dermal parasites did not appear to be similar all over Bonaire (Fig. 3.2, right; Fig. 3.3). The highest infection rates of the four common reef fish species and "all fish pooled" seem to occur along the west coast between the Salt Pier (Cargill Salt Bonaire N.V.) and Kralendijk. The lowest infection rates were observed on reference study sites (Red slave in the south, the three sites on the east coast and the two sites on Klein Bonaire). The northern study sites (around BOPEC) showed intermediate infection rates.

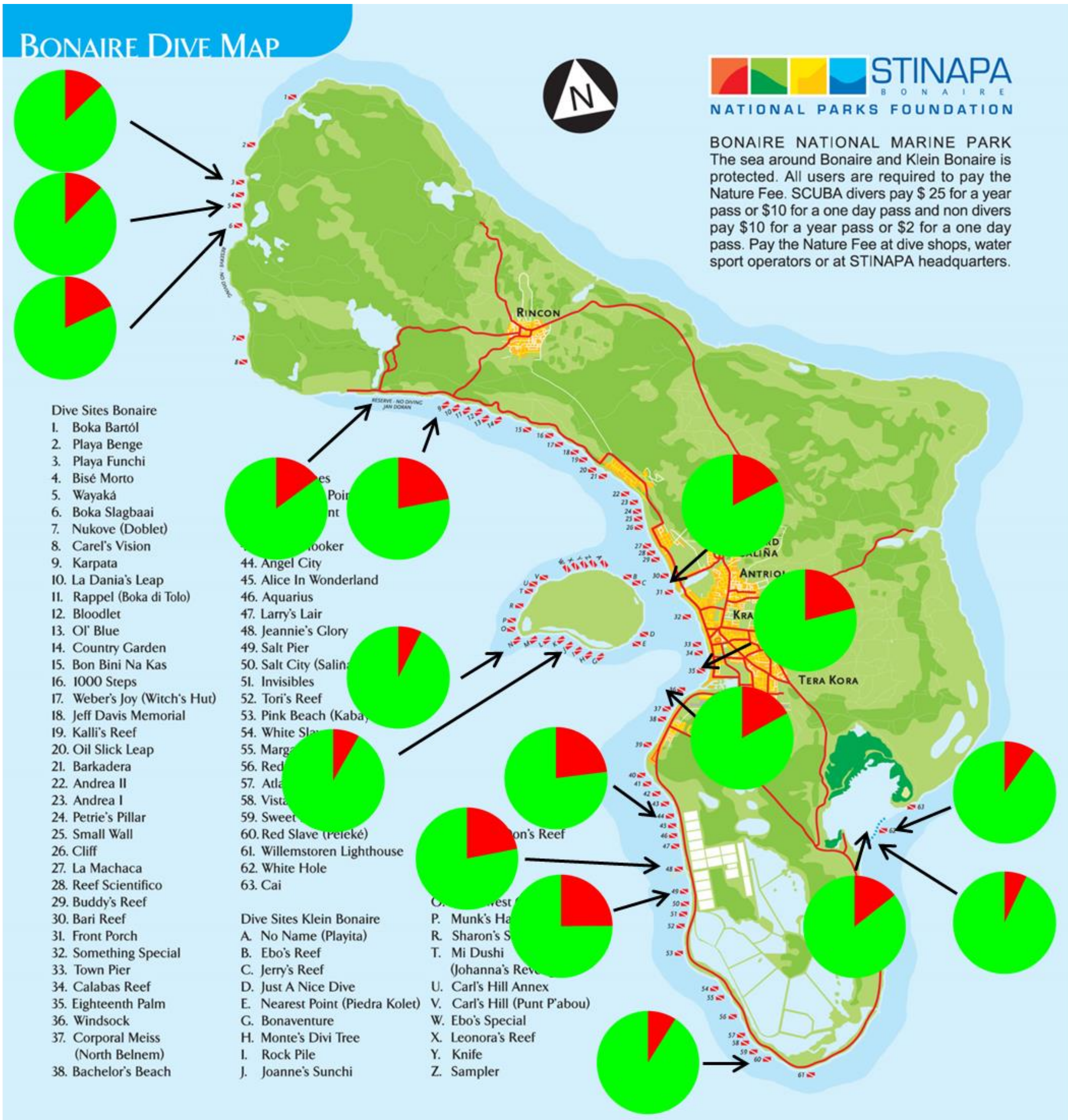

Figure 3.3 *Spatial variation in dermal parasite infection rates among the 17 study sites.*

3.3 Parasite infection rates in an environmental context

Increased parasite rates maybe correlated with water quality. The spatial differences in infection rates were roughly similar to the spatial differences in water quality reported by Slijkerman et al. (2014). Slijkerman et al. (2014) showed that threshold level for nitrogen were exceeded for urban and southern locations (i.e. ~City-Salt study sites), indicating eutrophic conditions, probably due to outflow of sewage water and to brine leaching into the sea from salt works.

A decline in environmental conditions (water quality) cause by wastewater or industrial pollutants can increase the prevalence of parasites in fish due to a diminished resistance to infections and decline in immunological defences (Sasal et al. 2007 and references therein).

In impoverished environments parasites with simple, single host life cycles (monoxenous) will proliferate. Monogenean parasites can be an indicator of water quality as these parasites are usually more abundant in eutrophic water (Valtonen et al., 1987) or other polluted areas (Skinner, 1982). Lafferty (1997) reported a similar increase in digenean abundance with eutrophication. However, anthropogenic activities such as increased pollution or fishing pressure can also cause a decline in the abundance and prevalence of heteroxenous (multi-host complex life history) parasites due to a lack of intermediate hosts (Sasal 2007 and references therein; Lafferty 2008).

The identification of the dermal parasite(s), their associated life cycles and the possible causes and/or ecological consequences of the widespread and extremely high prevalence of dermal parasites was not part of the 'quick scan' study and remain unknown. Since 2003 regular fish surveys have been conducted at several sites along the west coast of Bonaire (Steneck et al., 2013). Future co-operation with the research team of Dr. B. Steneck (University of Maine, USA) during a potential follow-up project may enable us to analyse trends in density and abundance of several heavily infected herbivorous species (e.g. ocean surgeon fish, redband parrotfish and princess parrotfish) in the geographic zone zones.

3.4 Recommendations for future research

Based on the results of the 'quick scan', we advise to a stepped follow up on this study, focusing on the type of parasite(s) and possible factors influencing the infection rate. More specifically:

- collect infected coral reef fish to identify the dermal parasite species,
- determine the life cycle of the dermal parasite species, i.e. heteroxenous (complex, multi host life cycle) or monoxenous (simple single host life cycle),
- a detailed study in the spatial and temporal patterns in the occurrence of dermal parasites, and
- determine the cause and effect of the extreme high prevalence of dermal parasites, including co-factors steering the high infection rates.

4. Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

References

Bak RPM .1977. Coral reefs and their zonation in the Netherlands Antilles. Stud Geol 4:3–16.

Becking LE, Meesters EHWG. 2014. Bonaire deep reef expedition I. IMARES C006/14, pp. 50.

Bernal MA, Floeter SR, Gaither MR, Longo GO, Morais R, Ferreira CEL, Vermeij MJA, Rocha LA. 2015. High prevalence of dermal parasites among coral reef fishes of Curaçao. Mar Biod. DOI 10.1007/s12526-015-0322-z.

Grutter AS, Hendrikz J. 1999. Diurnal variation in the abundance of juvenile parasitic gnathiid isopods on coral reef fish: implications for parasite cleaner fish interactions. Coral Reefs 18:187–191.

Lafferty KD. 1997. Environmental parasitology: what can parasites tell us about human impacts on the environment? Parasitology Today 13, 251–255.

Lafferty KD. 2008. Ecosystem consequences of fish parasites. J Fish Biol 73:2083–2093.

Lessios HA. 2005. *Diadema antillarum* populations in Panama twenty years following mass mortality. Coral Reefs 24:125–127

Pantos O, Bythell JC. 2006. Bacterial community structure associated with white band disease in the elkhorn coral *Acropora palmata* determined using culture-independent 16S rRNA techniques. Dis Aquat Org 69:79–88.

Sasal P, Mouillot D, Fichez R, Chifflet S, Kulbicki M. 2007. The use of fish parasites as biological indicators of anthropogenic influences in coral-reef lagoons: A case study of Apogonidae parasites in New-Caledonia. Marine Pollution Bulletin 54: 1697-1706.

Skinner RH. 1982. The interrelation of water quality, gill parasites and gill pathology of some fishes from South Biscayne Bay, Florida. Fisheries Bulletin 80: 269–280.

Slijkerman DME, de León R, de Vries P. 2014. A baseline water quality assessment of the coastal reefs of Bonaire, Southern Caribbean. Marine Pollution Bulletin 86: 523–529.

Steneck RS, Arnold SN, Rasher DB. 2013. Status and trends of Bonaire's reefs in 2013: Causes for optimism. University of Maine, School of Marine Sciences, pp. 124.

Valtonen ET, Koskivaara M, Brumme-Korvenkontio H. 1987. Parasites of fishes in central Finland in relation to environmental stress. Biological Research Report, University of Jyvaeskylae 10, 129–130.

Justification

Report : C055/15
Project Number : 431 681 0016 BO15 HD3569 Parasieteneffect

The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: Dr. D.M.E. Slijkerman
Onderzoeker

Signature:

Date: 1 April 2015

Approved: Drs. J.H.M. Schobben
Hoofd afdeling Vis

Signature:

Date: 1 April 2015