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FREE DIVING WITHOUT BREATHING APPARATUS

ITS ACCIDENTS

Underwater fishing, without aqualung, is an increasingly popular sport in the South Pacific lagoons. For the atoll-dwelling mother-of-pearl fishermen, however, diving is a professional activity likely to cause accidents. Prevention of these requires education and control.

In 1961, the South Pacific Commission published a Technical Information Circular (No. 49) on the Physiology of Skin-diving (with use of self-operating diving apparatus). In this document, the author, Dr. Y. MERLET, described decompression accidents. Since then, we have had occasion to mourn Dr. MERLET's death which occurred during an underwater diving expedition at Noumea.

Amongst the recent works held in the Commission's Medical Library, a few titles have been selected which may be of interest to readers:-

- 1) Bayliss, G.J.A. Diving fatalities in Australia
in Med. J. Aust. V.2, No. 27, pp. 1262 - 1264, 1966.
- 2) Bickmore, G.H. Some aspects of sub-aqua diving
in Practitioner, V. 197, No. 1175, pp. 204 - 207, 1966.
- 3) Bühlmann, A. Medical diving problems old and new
in Documents Geigy. Newspaper No. 3, pp. 6 - 7, 1967.
- 4) Davis, G.D. A Review of skin-diving hazards
in Med. J. Aust. V.1, No. 6, pp. 230 - 234, 1968.

- 5) Drown proofing
in HLTH (N.2) V.18, No. 1, p.7, 1966.
- 6) Gray, R.J. Underwater medicine
in Aust. Med. J., 15 Oct., pp. 774 - 776, 1966.
- 7) Lartigue, G. Les Accidents de l'eau
in Concours méd., No. 26, pp.5153 - 5164, 1967.
- 8) Lederer, R.J. Causes des accidents psychiques des candidats
à la plongée sous-marine
in Santé de l'homme, No. 150, pp. 38 - 41, 1967.
- 9) Sciarli, R. La plongée libre
in Concours méd. No. 27, pp. 4785 - 4794, 1966.
- 10) Steinmetz, W. Environmental aspects of scuba diving
in J. Environ. Hlth, V.30, No. 3, pp. 267 - 270, 1967.
- 11) Webster, B. Skin and scuba diving facilities in the
United States
in Pub. Hlth Rep., August, pp. 703 - 711, 1966.

In the Commission's files, two articles have also been found on the subject of accidents connected with free diving as practised by Polynesians in the Tuamotu Islands.

The first of these articles was written in 1956 by Dr. P.J. TRUC, shortly before he himself died while diving. The second article is the result of observations made by Dr. R. BAGNIS (Medical Oceanography Officer of the "Louis Malardé" Medical Research Centre in French Polynesia) when he was acting as Chief Medical Officer in the Tuamotu-Gambier Group in 1964. These two documents are being published today, in the belief that they will be of practical interest to the area's medical officers and divers.

If there are any amateurs who, over the weekend, spend a few hours diving, sometimes to a depth of 50 to 65 feet, it should be recalled that during the months of the "mother-of-pearl season" Tuamotu fishermen descend to depths of 24 fathoms (about 144 ft) in a free dive - i.e. without compressed air apparatus.

Before diving, they carry out a series of breathing exercises which ensure increased oxygenation, thus facilitating a longer stay underwater. Thanks to hyperventilation which completely

eliminates carbon dioxide from the lungs, it is possible to make the apnoea period approximately ten times longer; some divers, however, prolong this until they feel dizzy, thus masking the syncope prodromes on reascent.

It seems that in the region of 33 feet the pressure of alveolar CO_2 equals that of the CO_2 in the blood. In the region of 100 feet, half of the alveolar CO_2 has passed into the blood-stream. On reascent, the alveolar air dilates; the oxygen still available passes from the blood-stream towards the alveolus. Anoxia symptoms appear.

Dr. TRUC has noted slight haemoptysis. Also, acute oedema of the lung was observed on the island of Hikueru. This was caused by the effect of the pressure on the vital capacity and the residual volume of air, giving rise to transudation of the plasma in the alveoli. From the point of view of prevention, it may well be thought that measuring the varying lung volumes of divers would give them an indication of the depths to which they can descend in safety. At any rate, in view of the possibility of professional accidents, health education is necessary before and during the diving season.

Guy Loison, M.D., M.P.H.,
Programme Director (Health)

OCCUPATIONAL DISEASES OF DIVERS

by Dr. P.J. TRUC

I. "TARAVANA"

1. DEFINITION AND CIRCUMSTANCES OF ONSET

"Taravana" is the name given by mother-of-pearl divers to a wide variety of neurological injuries which they frequently suffer in the course of diving.

The accident generally occurs at the end of a fine, warm and calm day, with the sea-bed abounding in mother-of-pearl - all conditions likely to cause the appearance of "Nou Nou parau" or "mother-of-pearl madness". This fundamental concept is essential to the understanding of the genesis of "Taravana" accidents. In fact, under the impetus of "Nou Nou parau", the diver loses all caution and dives at an accelerated rate. He applies only 2 to 4 minutes' hyperpnea between dives, thus contriving to double the number of dives in a given period of time.

2. THE ATTACK

At this stage, "Taravana" abruptly makes its appearance. The only prodromes consist of disorders of vision allied to the Scotoma scintillans of ophthalmic migraine (visual hallucinations of shooting stars, twinkles of light, etc.) but these symptoms generally appear too late to alert the diver and to enable him to avoid the sudden attack of "Taravana". In fact, a few seconds after the appearance of these symptoms, in the course of the same dive, the diver is struck down by paralysis or, more rarely, by paresis.

This paralysis, in the great majority of cases, appears at the end of the dive just when the man is climbing up the rope to return to the surface or when he is trying to hoist himself onto the canoe. He then suddenly becomes aware of the fact that one of his limbs (monoplegia) or one side of his body (hemiplegia) remains inert and is completely useless.

His fellow crew member, who remains in the canoe, then lifts up his helpless companion. At this point the latter becomes subject to certain phenomena including dizziness, nausea and anxiety, impressions which the diver can describe very precisely: "He sees the canoe capsizing". This dizziness, whilst not invariably present, appears in approximately 60 to 70% of cases. The diver is obliged to lie down in the canoe with his eyes closed, and is brought back immediately to the village. On reaching the shore, whatever may be the extent of his nervous disorders, the traditional remedy is administered - i.e. he is given at least half a pint of rum (a quantity generally greatly exceeded).

The majority of former "Taravana" sufferers speak highly of the remarkable therapeutic merits of this treatment. Is this an effect of peripheral vasodilatation following upon the absorption of a strong dose of alcohol which, by promoting circulatory exchanges and releasing a possible angiospasm, would facilitate a more rapid reoxygenation of the anoxic neurons ?

The question remains unanswered. This tradition, unfortunately, prompts divers to take preventive measures against "Taravana" every day by ingesting alcoholic beverages at extra-medical doses.

It is unnecessary to emphasize that such therapeutic action - whatever may be its praiseworthy pretexts - should be viewed with extreme reserve.

3. VARIOUS FORMS OF TARAVANA

Out of 50 former "Taravana" sufferers questioned in person and through the medium of their family and friends, 42 had been affected by outright paralysis (mono- or hemiplegia), 5 had shown signs only of paresis varying in severity, lastly 3 proved to have suffered from psychopathological disorders.

I. PARALYTIC FORMS

These are therefore by far the most common forms of "Taravana". A clinical study of these forms of paralysis remains to be undertaken on the spot, in view of the lability of most of them.

The information acquired through anamnesis has proved inadequate for an accurate description of the basic neurological particulars concerning the clinical nature of these forms of paralysis,

and also of the reflexological disorders by which they are accompanied and located.

Nevertheless, the manner of their onset gives some hint as to the etiology, which may prove fruitful in respect of therapeutic results.

Monoplegia and hemiplegia are present in approximately equal proportions in the cases of paralysis investigated during this survey; right hemiplegia is always accompanied by aphasia.

Strangely enough the divers' accounts tally with regard to the general nature of these forms of paralysis.

Their onset is sudden, they are complete and unstable, embodying all the features characteristic of central paralysis.

All stress the sudden onset, at times heralded only by the ophthalmic migraine already mentioned.

These forms of paralysis are total and affect all the areas concerned at a single blow.

Lastly, they are unstable in the vast majority of cases, since 95 to 98% seem to be labile accidents followed by a complete remission.

The clinical examination of numerous divers who had been "Taravara" casualties once or several times during their careers, is categorical in this regard. No after-effects in the form of nervous lesions, no anomaly of the reflexes were found to confirm these neurological injuries.

Unfortunately, the situation is quite different in the case of the exceptions where the paralysis assumes a serious and irreversible form, and nothing is more saddening than the spectacle of these bed-ridden, disabled patients who are resigned to their fate, in the knowledge that they have been condemned without appeal.

These few cases should make us regard "Taravana" as a fearful "Sword of Damocles" constantly threatening the health and life of mother-of-pearl divers, and this is why a vigorous campaign should be undertaken with a view to forestalling its effects.

II. PSYCHOPATHOLOGICAL FORMS

Whilst the psychopathological forms of "Taravana" are less common than the paralytic ones, they are nonetheless important, for a complete cure is rare.

Numerous are the former divers who, during the whole of their lives, suffer the consequences, including a considerable reduction in their mental faculties. Moreover, these are the forms which impress the divers most and which make them attribute to the term "TARAVANA" a meaning closely akin to "odd" and "simple-minded". Some of these individuals remain prostrate for hours and days on end, unable to adjust to the most elementary physiological necessities, in a state of physical disintegration which can easily be imagined.

All forms of agnosia and aphasia can be observed, and the divers' accounts abound in precise and vivid descriptions on the subject. Any diver after his "Taravana" attack uses incoherent and unintelligible language, although he is perfectly capable of recognizing familiar objects and people. Agnosia, or difficulty in recognizing objects (or letters) and realizing what they are for, seems particularly common in the case of these patients and gives rise to misunderstandings which help to strengthen in divers' minds the notion of broad farce irresistibly conjured up by "Taravana",

4. ETIOLOGY OF TARAVANA (Study of the probable causes)

It would be tempting to draw a parallel between "Taravana" and the classic "bends" of aqualung divers, the so-called "decompression" accidents caused by the sudden release, on return to the surface, of the nitrogen dissolved in the blood under pressures of 4 to 5 atmospheres.

Now, these decompression accidents, the subject of remarkable studies by Paul BERT, and later by specialists of numerous national navies, from the "Diving-bell" era onwards, are basically different from "Taravana".

The very detailed study of the "bends" of aqualung divers for which we are indebted to the French National Navy's G.E.R.S. (Groupe d'Etudes et de Recherches Sous-marines - Underwater Research and Study Group) quotes the following as the symptoms of decompression accidents:-

- 1) Skin conditions
- 2) Osteo-muscular pains
- 3) Respiratory disorders
- 4) Nervous disorders.

None of the first three symptoms exist in the case of "Taravana", for the simple reason that they are caused by the formation of nitrogen aeroembolism in these various localizations. These accidents, common in the case of aqualung divers who remain submerged at depths of 100 to 130 feet for a prolonged period, could not occur in the case of "naked" divers who spend only 30 to 40 seconds at such depths. This is unanimously conceded by all physiologists; the nitrogen dissolved in the blood under such pressures can give rise to aeroembolism phenomena only if the pressure conditions are sufficiently prolonged.

Moreover, this physico-chemical law was used as the basis in preparing diving tables intended for aqualung divers wishing to come straight up to the surface in a single operation. In these tables a stay of less than 25 minutes at a depth of 100 feet and less than 15 minutes at 130 feet is prescribed. The "naked" diver therefore has ample safety margin in this direction.

The nervous disorders common to the "bends" and "Taravana" are also very different.

The "bends" always include the process whereby nitrogen is dissolved in the blood under prolonged pressure and causes aeroembolism when released.

When this embolism occurs in the marrow, it causes various neurological disorders. According to the work of G.E.R.S., the most common of these are forms of paraplegia or paralysis of the lower limbs; now, these forms of paralysis do not exist in the case of "Taravana". Moreover, their progressive onset, accompanied by tingling and loss of topesthesia would be sufficient to differentiate them from "Taravana" attacks, the sudden onset of which is well known.

Other nervous lesions caused by the "bends" can give rise to monoplegia, in the same way as "Taravana", but again as far as these forms of paralysis are concerned, the manner of their onset is sufficient to allow a difference to be drawn.

Furthermore, the concept of depth which is so important in the genesis of the "bends" seems to have no part to play in connection with "Taravana", for in that case accidents are just as common in

shallow waters, during the first month of the diving season, as during the last month when divers descend to depths of 115 to 130 feet.

If it is not a matter of aeroembolism as in the case of the "bends", what is the cause to which "Taravana" can logically be traced ?

The most likely hypothesis rests on the concept of "Nou Nou parau" and the repeated dives at an accelerated rate which invariably precede the attack. At the root of the accident, therefore, lies a phenomenon whereby the body is deprived of oxygen for, more than any other, the grey nerve cell - the neuron - is sensitive to this anoxia. That this anoxia should be accompanied by an angiospasm is a plausible hypothesis which would explain the differences in the duration of the accidents, varying from a few hours to a few days, and perhaps also the beneficial action of the alcohol absorbed in strong doses.

The anoxic origin of "Taravana" seems confirmed, moreover, by the complete absence (admitted by all divers) of these accidents amongst those of them who observe the rules of the "Mangavera technique". Once again, the only original point of this technique consists in spacing out the dives by a pause at least twice as long as that practised by the Tuamotu divers.

This hypothesis has the advantage of opening up a logical therapeutic path to these "Taravana" accidents and offers the possibility of checking up on its origin in consequence. With this end in view, it would be useful to start treating these casualties as soon as possible by means of vasodilatating substances and oxygen therapy under pressure.

II. TOPATARI*

This term, for fishermen, means drowning, without any distinction in the physiological processes.

Such accidents are still too common (two in 3 months during the 1955 season on Hikueru Island alone) and should probably be ascribed to a bulbar syncope, understandable in the case of those who work on the extreme boundary-line of anoxia.

* TOPATARI = sudden malaise, involving the fall and disappearance of the diver.

III. VASCULAR ACCIDENTS

The diver coming out of the water often notes the appearance of an epistaxis or a slight haemoptysis.

He does not worry unduly about these accidents regarded as harmless and no doubt to be attributed to the considerable pressures and depressions inflicted at too close intervals on the peripheral vascular system.

The slackening of these differences in pressure on the fine blood vessels which irrigate the cavities with rigid or semi-rigid walls (nasal cavities, upper airways, middle ear etc.) and experience a slight delay in balancing their own pressure in relation to that of the surrounding medium, can lead to vascular ruptures giving rise to these slight haemorrhages which are not serious.

IV. COLIC

A well-known complication in the case of aqualung divers. G.E.R.S. physiologists attribute it to unduly rapid pressure and depression of the abdominal organs, entailing sudden variations in the volume of gases contained.

V. HEART AND LUNG INJURIES

At the risk of disappointing the defenders of certain classic theories too rapidly conceded and insufficiently sifted by scientific criticism, it must be admitted that no record of any heart or lung lesion has been found in the case of seasoned professional divers.

(Furthermore, how would they have resisted an injury of this kind under such working conditions?).

This seems a suitable point at which to recall the case of two experienced divers over the age of 60, each of whom had more than 30 diving seasons to his credit, and whose hearts and respiratory systems were in perfect condition.

The example of two veterans of this stamp must surely obviate the need to put forward statistics showing the very large number of divers at the height of their activity and in the best of health who are well beyond the age of forty.

VI. EAR INJURIES

It has previously been said that the diver knows perfectly well how to spare his eardrums by decompressing his middle ear during his frequent descents - rapid though they are.

This technique is the A.B.C. of the art of diving and it can be affirmed at this point that burst eardrums are rare in the case of professional divers, and always accidental. They can be caused by an inflammatory obliteration of the Eustachian tubes through rhinitis or sinusitis, for instance.

This injury, moreover, leads to a period of inactivity on the part of the diver, corresponding to the length of time required for the injured eardrum to heal.

To what extent does the inner ear cause the dizziness which frequently accompanies "Taravana" accidents? In order to be given a valid answer, this question would need to be investigated by a suitably equipped specialist who would be in the diving area at an opportune moment; these are conditions difficult to achieve in the Tuamotu Group.

COMMENTARIES ON 35 CASES OF FREE DIVING ACCIDENTS OF THE "TARAVANA" TYPE, IN THE TUAMOTU AND GAMBIER ISLANDS

by Dr. R. BAGNIS, Medical Officer - Naval Captain

DEFINITION: The inhabitants of the Tuamotus describe as "Taravana" any mother-of-pearl diver who has suffered an injury of a neurological or psychic type in the course of diving.

GENERAL : The following comments concern 35 "Taravana" cases which occurred in the course of the 1964 diving season on Hikueru from 15th January to 15th May 1964. The observations were gathered either by the Chief Dresser of the Medical Diving Station, or the visiting Medical Officer of the Tuamotus whilst in the diving area.

No previously reported case has been used in this Report. Roughly at the same period the diving season was taking place on Mangareva in the Gambier Islands, in the course of which no "Taravana" case was notified.

INCIDENCE AND DISTRIBUTION OF THE ACCIDENTS IN THE COURSE OF THE SEASON

1st month: 7 cases
 2nd month: 20 cases
 3rd month: 7 cases
 4th month: 1 case

AGE OF THE DIVERS CONCERNED

Under 25 years : 6 cases out of 28 divers - approximately 21%
 25 to 35 years : 17 cases out of 182 divers - approximately 9%
 35 to 45 years : 7 cases out of 56 divers - approximately 12%
 over 45 years : 5 cases out of 43 divers - approximately 11%

Circumstances of onset:

Generally at the end of the diver's working day, i.e.
 between 1 p.m. and 3 p.m.

FACTORS IN FAVOUR

- calm lagoon - clear and cold water - good light conditions so that the rich mother-of-pearl beds can be seen clearly;
- sheets of water of different temperatures;
- accelerated diving rate without sufficiently prolonged reoxygenation in the diving interval (3 to 5 minutes);
- absence of real compensating rest periods in the canoe. The divers merely remain with their heads above water, hanging on with their hands to the arm of the outrigger;
- accumulated fatigue dating back to the Takaroa diving season which had taken place from the beginning of September to the end of November 1963.

CLINICAL FACTORS

Prodromes: invariably present

- generally appear when the diver is on the bottom
- consist of visual hallucinations: twinkling of light, sparkling dots. Divers say that flashes appear in their masks or goggles. At that moment they know they are going "to be Taravana" and try to ascend to the surface without delay.

Established case: A distinction should be made between the neurological and the psychic forms.

A) Neurological forms: mainly paralytica) Variety of injuries in the course of the diving season and number of cases in each category.

- monoplegia of an upper limb	: 7
- monoplegia of a lower limb	: 3
- brachial monoplegia combined with a homolateral facial paralysis	: 1
- left hemiplegia	: 7 (of which 1 was a relapse)
- right hemiplegia with aphasia	: 4 (- d ² -)
- paralysis of one half of the tongue	: 2
- isolated facial paralysis	: 2
- quadriplegia	: 3
- paresis of the lower limbs	: 2

b) Onset of paralysis: Suddenc) Nature of paralysis

Whatever may be the area affected, the paralysis has well-defined clinical characteristics:

- it immediately strikes all the muscles which are going to be affected
- it covers the whole of the area concerned
- it is flaccid, with abolition of the tendon reflexes
- it is accompanied early on, in the extended forms, by vasomotor disorders together with cyanosis, fall in skin temperature, dyspnea.

d) Regression of paralysis

- No sooner formed, than the paralysis seems to be entering the regressive phase.
- Within a few hours, some groups of muscles recover their strength and functions.
- Within 3 or 4 days, abatement of the paralysis is virtually complete.
- On a single occasion some twenty days were required to effect a cure.

e) After-effects: absent

The slight decrease in the strength of one group of muscles noted in two cases had retroceded after one month.

f) Finally, as regards these cases of paralysis, the absence of Babinski's sign, sensitivity disorders and sphincter disorders should be noted.

B) Psychic forms

a) Psychic disorders were observed in the case of patients who were, moreover, free from neurological lesions.

b) Variety of casualties and number of cases

- 2 cases of logorrhea with incoherent statements uttered in a loud voice by individuals who seemed to recognize the people belonging to their circle of family and friends, as well as some familiar objects, but who were unable to focus their attention and to reply to questions put to them.
- 1 case of real psychic apathy with anxiety and prostration.

c) Nature of the disorders: all seem to appear with equal suddenness:

- It was easy to determine the manner of onset of the injuries in the two cases where verbal excitement dominated the scene: diver speaking in a loud voice as soon as he came out of the water, sitting down in his canoe and continuing a monologue which even his immediate circle found difficult to understand, taking no notice of his surroundings.
- On the other hand, the change of mood and the mental torpor noted in the last case were less spectacular and could be linked with their real etiology only after three days.

C) Allied form: one case

- right hemiplegia together with aphasia accompanied by a state of verbal excitement with anterograde amnesia,
- recovery, within three days, of peripheral motor functions,
- recovery, within one month, of normal speech,
- it should be noted that the case in point was one of a "Taravana" relapse which occurred during the Takaroa diving season, and of which the characteristic feature was a brachial monoplegia. This had subsided within 2 days.

THERAPEUTIC FACTORS

a) Indigenous - Divers affected by "Taravana" placed in the open air

- generalized massage of the body with "Vicks", concentrating predominantly on the groups of muscles affected,

- absorption of $\frac{1}{2}$ litre of sweetened rum within approximately 1 to 2 hours.

b) Medical:

- vasodilators, antispasmodic drugs, tranquillizers, rehydration have been used, but they do not seem to have had a marked influence on the progress of the condition.

PHYSIO-PATHOLOGICAL FACTORS

a) Medical literature does not abound in comments on "Taravana" type accidents, or in comparative studies of "Taravana" accidents and decompression accidents observed in the course of dives with compressed air apparatus.

b) For Dr. TRUC, the mechanisms which produce the two varieties of disorders are eminently different, and this would explain the absence, in the course of "Taravana" accidents, of certain symptoms regarded as classic in the "bends" of aqualung divers (cutaneous, osteo-articular and respiratory symptoms).

Moreover, the nervous disorders common to the two varieties of accidents differ in the manner in which they appear and in their characteristic features.

Finally, the psychic disorders are far more exceptional in the accidents which occur during dives with compressed air apparatus.

Furthermore, in his argument Dr. TRUC puts forward a special factor - i.e. the absence of "Taravana" in the case of divers of the Gambier Group, whose methods differ from those of the Paumotu divers on Hikueru; this absence is explained by the observation of a prolonged pause, approximately 15 minutes in length, together with a rest period on board the canoe.

c) The fact that the diving season on Mangareva (in the Gambier Islands) coincided with that of Hikueru (in the Tuamotu Group) at the beginning of 1964 enabled the writer to make the following personal observations, most of which confirm and complement Dr. TRUC's statements:

On Hikueru as on Mangareva

- 1) the divers spend 6 to 7 hours in the diving areas,

- 2) the periods of submergence are appreciably of the same length, decreasing slightly between the beginning and the end of the day. They vary on average between one minute 30 and one minute 40 for each dive.
- 3) the length of stay on the sea-bed is 40 seconds on average in the case of each dive.
- 4) the average depth of sea-bed available for mother-of-pearl fishing varies from 10 to 15 fathoms at the beginning of the diving period to 20 to 25 at the end (1 fathom: approximately $5\frac{1}{2}$ feet in the Tuamotus).

However, whereas on Mangareva the number of divers does not exceed 100, it is at least 300 on Hikueru, and in this abundance of competitors lie the reasons for the accelerated diving rate practised on Hikueru. Indeed, for a roughly identical prospecting area, the number of divers is three times as high. In order to mitigate this handicap of numbers, many Paumotu divers sacrifice the safety they would derive from longer reoxygenation between dives, in favour of "Nou Nou parau" (mother-of-pearl madness).

- To support these facts:

- 1) The highest number of accidents (20 cases) occurred during the second month of diving which provides the largest quantity of mother-of-pearl.
- 2) The divers most prone to "Taravana" accidents were young men under 25 years of age, in a flourishing state of health, with a confidence unbounded by their means (17 cases between 25 and 35 years of age) and who thought they were proof against spectacular accidents (for the only ones to make an impression on the young are psychic accidents).

- The result is that:

- 1) On Mangareva, each diver goes down to the sea-bed approximately 35 times per day, whereas on Hikueru the descent figures exceed 70.
- 2) On Mangareva, most of the divers take their time to have a snack during the one hour rest period they grant themselves half-way through the working day, whereas on Hikueru, only a small minority of divers allow themselves a similar break.

- 3) The average length of a Mangareva diver's daily submergence is half that of a Paumotu diver (45 minutes as against 90 minutes).
- 4) The daily stay under a pressure of 3 to 4 atmospheres is approximately 45 minutes for a Paumotu diver, whereas it is 25 minutes for a diver from Mangareva.

Of course, no greater value should be attached to these figures than that given to average statistics, since "Taravana" accidents often occur when the diver oversteps the classic safety norms handed down from generation to generation of divers.

However, it cannot be denied that, whatever may be the intimate pathogenic mechanism of "Taravana" accidents, two special facts are worth taking into consideration:

- in the first place, the maximum duration of the daily apnoea with the invariable tendency towards anoxia,
- in the second place, the maximum duration of submergence in deep water, with the influence of the increased pressure on the blood gases.

a) The rôle of anoxia: this seems to be fundamental in determining "Taravana" accidents, as remarked by Dr. TRUC, either by direct action on the nervous cell which has very high oxygen requirements, or through the medium of an angiospasm.

b) Whilst the conditions present during decompression accidents which occur in the course of dives with compressed air apparatus cannot be superimposed on those present during free dives, yet the repercussion of the increased pressure on the blood gases can be affirmed with certainty.

It is known that the solubility of blood gases increases in proportion to the pressure applied. When this dissolution has reached the blood saturation rate, the gases will be able to spread to the other tissues.

Such a phenomenon cannot occur during the 40 seconds of a single stay on the sea-bed. However, one may wonder whether, following a summation effect at the end of a day's diving, when the sum of the periods of time spent under a pressure of 3 to 4 atmospheres reaches 30 to 40 minutes, all the conditions are not given for a temporary release of gas bubbles into the tissues made fragile by anoxia to occur at the time of the diver's ordinary rapid reascent (approximately 20 seconds).

Such a hypothesis would need to be supported by the experimental study of the physical and chemical changes undergone by the blood gases under the influence of numerous successive passages from atmospheric pressure to a triple or quadruple pressure.

c) Connection between "Taravana" and high blood pressure

A systematic study of the blood pressure of Hikueru divers was carried out. Thanks to this study it was possible to ascertain that "Taravana" accidents occurred without distinction in the case of people with the most widely diverging blood pressures.

CONCLUSIONS

A fragmentary survey suffering from such a lack of perspective will only allow hasty conclusions to be drawn with regard to the pathogeny of the "Taravana" syndrome. It would, however, seem useful to conclude by stressing a few particular considerations, namely:

1. the transient nature of the accidents observed,
2. the rapid onset of recovery solely through prolonged respiration of normal air at atmospheric pressure,
3. the absence of the influence of therapeutics on subsequent development,
4. the serious nature of cases of relapse,
5. the need for an investigation in the diving area of the changes undergone by blood gases under the influence of successive pressures and decompressions, a task which could only be undertaken by a specialized visiting laboratory.

MEASURES RECOMMENDED FOR POSSIBLE PROPHYLAXIS

In the absence of precise knowledge of the physio-pathological mechanism of diving accidents, a rational prophylaxis of these accidents cannot be carried into effect.

However, in the light of the findings established during the last few diving seasons in the Gambier and Tuamotu Islands, it can be affirmed that the best means of preventing neurological diving accidents consists in observing the following instructions:

- a single annual diving season, always at the same period;
- a strict medical examination with a view to eliminating the least resistant individuals, in particular lung and heart cases;
- a reduced number of daily dives (a maximum of 30);
- an increased rest period between two dives (a minimum of 12 to 15 minutes);
- the rest period (to be observed on board the canoe) should be used to advantage by practising deep breathing exercises with a view to ensuring maximum reoxygenation without, however, reaching the stage of forced hyperventilation with its attendant syncope hazards;
- former "Taravana" subjects should be prohibited from diving, since cases of relapse always seem to be more serious than first accidents.

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Noumea, March 1969

ISSUED IN THIS SERIES

Classification

- | | |
|------------------------------------------------------------------------------------------------------|---------------------------------------|
| 1. Annual Conference of O.I.E. held in Paris 13-18 May 1968, Report of SPC Observer. September 1968. | Livestock
Production
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| 2. South Pacific Commission Publications' Series - Recent Developments | Publications |
| 3. Free Diving without Breathing Apparatus - Its Accidents. March 1969 | Public Health |

