ACOUSTICS AND NOISE CONTROL IN CANADA

THE CANADIAN ACOUSTICAL ASSOCIATION

L'ACOUSTIQUE ET LA LUTTE ANTIBRUIT AU CANADA

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CONTRIBUTIONS

Articles in English or French are welcome. They should be addressed to a regional correspondent or to a member of the editorial board.

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CONTRIBUTION

Vous êtes invités à faire parvenir des articles en anglais ou en français. Prière de les adresser à un correspondant régional ou à un membre de la rédaction.

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(suite au recto de la couverture inférieure)

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EDITORIAL (Based in part on editor's report to the Annual Meeting in Edmonton, 9 October 1974)

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The Newsletter has continued to be published quarterly. It circulates approximately in the middle of each calendar quarter, and thus might appear to some people to be always 6 weeks late. This is not so, it is planned that way since the Annual Meeting of this organization in Mid-October a year ago. This present issue will be even more delayed as a result of special circumstances.

We have a steady circulation list of about 300, which is about twice the apparent membership of the Canadian Acoustical Association. There is a continuing problem to find enough useful and relevant material to produce each issue - we rarely have a backlog and sometimes have had to put out a very thin issue. This is our most serious problem by far, and unless the flow of articles, news items, etc., increases considerably it will be fatal for the newsletter. There is a limit to how much material one can, or even should, put in that emanates from only one or two organizations. We need widespread authorship as well as our country-wide readership. I hope that authors of papers at the annual meeting will write up and submit their papers for consideration, either completely or at least in abstract form. The first of these, on Whale Acoustics by Peter Beamish, appears in this issue.

It is with great personal regret that the editor must announce the resignation of Donald McKay from the Editorial Board. Don has borne the major share of work in producing the Newsletter from its inception two years ago, and without his efforts the Newsletter would often have appeared later in inferior form, or not at all. Fortunately he has agreed to continue to keep a watch on the printing and mailing of the Newsletter.

Our Chairman has appointed Garry Faulkner of the University of Alberta

as a new member of the Editorial Board and we look forward to working with him in the coming year. The editor recommended to the Annual Meeting that he should retire at the time of the next Annual Meeting - he feels that after three years that it is beneficial to bring in new ideas and different personal contacts.

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MINUTES OF THE 12th MEETING OF THE CANADIAN ACOUSTICAL ASSOCIATION HELD IN EDMONTON, ALBERTA, OCTOBER 10th, 1974

ICA, IUPAP and CAA

The meeting, with 27 people present, opened with the chairman H. Jones reading a letter he had received from E.A.G. Shaw. It appears that the International Commission for Acoustics (ICA) is now aware of the existence of our organization (CAA) and in future we shall receive information and enquiries from the Commission. At the moment ICA is a special Commission of the International Union of Pure and Applied Physics (IUPAP) and as such receives financial support. It has been suggested that there should be a change of statue and that ICA should become an affiliated commission. This would mean that representation would be by national societies rather than by individual scientists, the national societies would be represented on a General Assembly for Acoustics which would elect the Commission, and that the ICA would no longer receive support from IUPAP but would have to impose a levy on the national societies such as ours. It had been agreed that acoustics is so broad a field that it would be better if there were no direct control from IUPAP. E. Shaw mentioned in his letter that he knew of no case where ICA had been hindered by IUPAP and that the present system had political advantages, he recommended that we support the continuation of the present arrangement.

A motion that we support the status quo was moved by J. Manuel, seconded by T. Northwood and carried with 4 abstentions.

NEWSLETTER

The Newsletter editor's report was presented in a letter from T. Embleton. He drew attention to the fact that we had decided in a previous meeting that the Newsletter would appear in the middle of each calendar quarter, which would explain why some recipients wonder if they are receiving their copies late. He pressed the need for more material and more widespread authorship which if not forthcoming might prove fatal to the survival of the Newsletter. He expressed his willingness to remain editor for a further year but would then retire as he will have been editor then for 3 years. The meeting assured the editor of its appreciation and a motion on this moved by J. Foreman and seconded by B. Dunn was carried unanimously.

Discussion turned to the contents of the Newsletter and the ramifications of publishing technical papers in it. Would prior or subsequent

publication in another journal, for instance, vitiate against this appearing in the Newsletter? This problem could be more or less immediate as it is planned to publish some of the papers presented at this meeting in some form in the Newsletter. For instance some scientific journals will not publish papers which have appeared elsewhere. The subsequent or prior appearance of an abstract of the paper would present no problem but the same article in two publications might. The Newsletter was seen as performing a function somewhat similar to that of the British publication Nature, a method for obtaining publication with relatively little time lag. One of the most likely places of conflicting publication would be the Journal of the Acoustical Society of America (JASA). The motion was moved by D. Allan that the Newsletter be the method for rapid dissemination of Canadian efforts in the field of Acoustics before or after previous acceptance of publication in other journals. J. Foreman felt that specific Canadian articles might not be relevant to U.S. journals and that the full list should be in a proceedings (presumably the Newsletter grown apace) with suitable acknowledgements if they had been previously published. E. Bolstad had a feeling JASA would not worry (some members disagreed) about previous publications in a Canadian journal and that the members (and others) should wish to see their articles in a national journal. There was some question as to whether our Newsletter, which is free, could be classed as a journal. D. McKay thought that we were (or soon would be), as we now send copies to each University library and plan to send them to institutes of technology. With a wider circulation money could be a problem and we might have to develop a mechanism for getting fees. P. Beamish saw the publication growing with the size of the Association and that the papers we publish would be in proportion to our prestige. In fact the format should get better every year. In discussing his motion D. Allan felt we could keep the situation reasonably loose by encouraging the first draft in the Newsletter and hoping for the best. C.W. Bradley thought the Newsletter could go either the way of Noise News or become a scientific journal. D. McKay felt we should be concerned with the dissemination of Canadian efforts. The motion was carried with 26 in support.

E. Bolstad proposed that the present editor be confirmed in his position for another year; seconded by C.W. Bradley and carried unanimously.

J. Foreman explained how the regional officers had been originally appointed. It was proposed by B. Dunn and seconded by D. Whicker that the regional officers should be appointed on the jurisdiction of the editor. T.D. Northwood felt the editor should have the power to co-opt members and that the organization should help by offering volunteers. G. Thiessen thought it wrong to tie the editor up in red tape. The motion was carried unanimously.

INC PUBLICATIONS

The motion was proposed by W. Barss and seconded by G. Thiessen that the editor look into the possibility of obtaining favourable rates from INC (Institute of Noise Control) for those members wishing to obtain INC publications. E. Bolstad questioned whether this might be stretching

the constitution of INC which was specifically a US organization. G. Thiessen explained that membership of INC was open to all (although INC covered a field of interest more restricted than that of the CAA and so we should not seek affiliation, for instance) and that they were trying to form an international group. The motion was carried.

CAP and CAA

The chairman, H. Jones, proposed that we discuss our position relative to the Canadian Association of Physicists (CAP). Although CAA was not primarily a physics organization we had to remember that similar groups to ours in other countries have an association with physics organizations. The possibilities as the CAP sees it are:

1) to form a division of CAP, which has been traditionally weak in acoustics - the latter is lumped with solid state physics at the present,

2) affiliated membership with an annual fee of $15 per member. We would then have any advantages arising from membership,

3) a more flexible arrangement, which CAP would be willing to discuss.

G. Thiessen, himself a member of CAP, explained how he had once tried to interest CAP in an applied physics group but with little success. Acoustics, where the interest is narrower, would present an even more difficult case. He saw no advantage in any ties with CAP. T.D. Northwood agreed and recalled in the early days of CAA (then the CCA) they had sponsored a joint meeting, with the result that it was our smallest meeting. J. Foreman was reluctant to close off all contact as he felt there might come a time when we might wish for cooperation. He suggested that we inform CAP of our emergence and that we might like to reopen discussions in the future when we were more mature. G. Thiessen objected to the implication that we were somehow inferior. H. Jones suggested we avoid the topic at the present and J. Foreman cautioned that it would be wrong to object to affiliation itself.

EXECUTIVE COMMITTEE

The chairman then introduced the subject of the formation of an executive committee. He suggested this committee would comprise the chairman, past chairman, secretary, chairman of the editorial committee, programme conveners of the present and next annual meetings, treasurer (see below) and up to three co-opted members to represent either geographical areas or special interests. The policy of such an executive would be to:

1) consider and advise the Association on its policy for development,

2) foster the professional interests of the Association by establishing a more recognizable liaison with similar groups in other countries,

3) assist government by recommending individuals who are willing

to give unpaid professional advice of a general nature relating to acoustics with the intention of assisting government in its policy decisions,

4) maintain liaison with appropriate standards committees,

5) establish study groups where this would be appropriate.

C.W. Bradley wondered about the large size of the executive but J. Foreman saw no difficulty here. The chairman explained he had approached six members at random on these ideas and had received 5 responses in favour, and one lukewarm reaction - this member was concerned at the cost of any travel that might be entailed. D. Allan felt there was no need to question the members and agreed that the chairman should be able to seek advice from a small group when making decisions, and then instruct a member to take action. T.D. Northwood moved we form such an executive and this was seconded by J. Foreman. The motion was carried.

L. Russell moved the acceptance of the scope of the executive's functions as outlined by the chairman; J. Manuel seconded. B. Dunn felt the list might prove too restrictive and suggested that 'such as' should be prefixed to the list. The mover and seconder accepted this. J. Foreman suggested 'government' in clause 3 should be changed to 'government and other agencies'. Again the mover and seconder concurred and the motion was carried.

NEXT YEAR'S MEETING

E. Bolstad recommended that next year's meeting be held in Toronto and this was seconded by D. Allan. The motion was carried.

TREASURER AND MONEY MATTERS

The chairman explained that as we now had $50 donated to us by General Radio we had provisionally adopted E. Bolstad as our treasurer. J. Manuel moved we confirm this appointment and that the present chairman and secretary continue for the next year; B. Dunn seconded. The motion was carried unanimously. The treasurer then made his report. In addition to the $50 we had another $74 raised by registration fees. C.W. Bradley mentioned that this was the first meeting when funds had been collected and that there had been no prior decision to do this. W. Barss explained that the money raised would be used to cover the meeting charges, etc., that had been incurred at the current meeting. A. Anderson proposed that the meeting confirm the committee's action. This was seconded by J. Manuel and passed unanimously.

B. Dunn proposed, and W. Barss seconded, that future registration fees be charged at the discretion of the committee. J. Foreman proposed an amendment, eventually withdrawn, that a vote should be put to the membership. C.W. Bradley moved another amendment, B. Dunn seconded, that the executive be given power to assess a fee not in excess of $5. D. Allan argued it wrong to make a restriction on a definite dollar basis and the mover and seconder agreed to change 'not in excess of $5' to as 'low as possible'. The amendment and motion were carried.

P. Beamish thought that some effort should be made into raising money so that one issue of the Newsletter each year could be of improved quality. J. Foreman agreed and wondered whether we should consider levying a membership fee. D. Allan questioned that this might jeopardize the free publication arrangement we have with the federal Department of the Environment. D. McKay felt that at some point the policy of free publication would no longer be supported anyway. G. Thiessen knew of many instances of Government supporting publications and organizations which charged fees, but pointed out we would have to be a lot more formal when money is involved, e.g., income tax and filing evidence on the category of the organization. D. McKay mentioned it would be easier for Environment Canada if a charge were made for the publication: and in response to a suggestion from the chairman that we might be considered a more formal entity in view of the motions we had passed at this meeting, he pointed out that the meeting had no legal significance and that we were not recognized in the 'Societies Act'. T. Northwood questioned the collection of money before we had an established need. P. Beamish suggested the executive study how much it would cost to produce an improved version of the publication, how we could obtain such money and that we should vote on it at the next meeting. G. Thiessen again cautioned on the consequences of charging fees and pointed out that we should have to have an audit each year.

A. Anderson felt there should be some form of legal entity of the association and that we needed protection under some form of 'Societies Act'. D. Allan promised to look into the legal aspects. E. Bolstad felt that when one had legal status there had to be a constitution. We had always attempted to avoid this although some members were sure there were standardized constitutions which could be used. D. McKay said it would be easier to accept gifts if we had a constitution.

J. Foreman then made a formal recommendation that the executive investigate whether there is a legal requirement that must be satisfied should we establish ourselves as a membership paying organization, and further that the executive study our projected operating costs including the publication of an improved Newsletter in the form of a proceedings. T. Northwood suggested the executive also study the cost for us to become a registered organization and also its advantages.

FINALE

L. Russell moved we make J. Manuel the convener for the next meeting. Seconded by T. Northwood and carried unanimously. B. Dunn proposed a vote of thanks to the executive and the present meeting organizers. Seconded by J. Manuel; carried unanimously.

The adjournment was then moved and carried.

SOUND AND VIBRATION LABORATORY OF THE UNIVERSITY OF WESTERN ONTARIO SUBMITS REPORT TO THE ONTARIO MINISTRY OF THE ENVIRONMENT ON NOISE MEASUREMENTS AND ATTIDUDINAL SURVEYS OF URBAN CENTRES

The Sound and Vibration Laboratory of the Faculty of Engineering Science, The University of Western Ontario, recently completed a major project for the Ontario Ministry of the Environment, sponsored by the Ministry and the City of London, as part of an overall study by the Ministry to provide background information on existing noise levels and community subjective response to these levels in urban centres in Ontario. This information is to assist the Ministry in formulating community noise regulations for the province as a whole, to aid municipalities in interpreting and implementing these provincial regulations on a local level and to provide guidelines for future long-term urban planning.

The project involved a study of physical noise measurements in combinations of residential, commercial, industrial and institutional land-use areas in the cities of London and Woodstock through automatic monitoring and data retrieval and processing systems, together with assessing reactions to the noise levels in these land-use areas through an opinion survey utilizing an appropriate interview and questionnaire technique. The data from these two surveys have been reported to the Ministry in three separate reports: Report No. 1 in September 1973 and Nos. 2 and 3 in October 1973. A summary of this project and its findings was published in the September issue of Sound and Vibration.

The project was conducted under the direction of Professor J.E.K. Foreman, Director of the Laboratory, assisted by Dr. S.M. Dickinson of the Laboratory, Dr. E.B. Harvey of the Ontario Institute for Studies in Education, Dr. L.S. Marsden of the Population Research Group at the University of Toronto, and Mr. M.A. Emmerson of the Department of Geography at Western. Advice and personnel, both faculty and students, were available from various departments in the Faculty of Social Science, the Faculty of Medicine, and the Faculty of Science.

SOUND AND VIBRATION LABORATORY OF THE UNIVERSITY OF WESTERN ONTARIO AWARDED CONTRACT FROM THE CANADA MINISTRY OF TRANSPORT

The Sound and Vibration Laboratory of the Faculty of Engineering Science, The University of Western Ontario, has been awarded a $30,000 contract to conduct a study for the Ministry of Transport on external vehicle noise and its health-impairment effects on people. The purpose of the study is to assist the Ministry in data gathering and analysis, to develop further the Canada Motor Vehicle Safety Standards as they relate to external vehicle noise.

The proposal submitted by the Laboratory involved a project to be carried out in two phases: Phase I, for which the current grant has

been awarded, consists of a comprehensive survey and analysis of relevant work in the world wide literature to date, using a computer-based system for data handling; the computer storage of the references permits easy duplication of the sorted indexes, and it is hoped that copies of the final version will be available to interested parties. Phase II of the project, for which the precise procedures will depend on the results and analysis of the data gathered in Phase I, is expected to involve direct experimental investigation of the intensity of traffic noise (derived on a statistical basis through automatic monitoring and processing procedures) at various high-density traffic locations across the country, together with a survey of attitudinal responses through various questionnaires and interviews on the effects of traffic noise on health. The principles of Phase II have been tentatively approved, and this part of the project is currently under negotiation with the Department.

The project is being carried out under the supervision of Professor J.E.K. Foreman, Director of the Laboratory; Dr. J.S. Bradley is coordinating the project assisted by Mr. M.A. Emmerson, a postgraduate student in the Department of Geography. The Laboratory's efforts will be complemented by resource personnel from other units in the University, in particular the Department of Psychology and the Faculty of Medicine.

WHALE ACOUSTICS

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INTRODUCTION

Four of the larger cetaceans have been found to emit "echolocation-type" sounds. These are one species of the suborder Odontoceti (toothed whales), the sperm whale *Physeter catodon* (Backus and Schevill, 1966) and three species of the suborder Mysticeti (baleen whales), the blue whale *Balaenoptera musculus* (Beamish and Mitchell, 1971), the Minke whale *Balaenoptera acutorostrata* (Beamish and Mitchell, 1973) and the Gray whale *Eschrichtius robustus* (Fish *et al*, 1974).

Five species of the family *Delphinidae* (smaller toothed whales often called dolphins and porpoises) have been demonstrated to use functional echolocation during experimentation with captive animals. These include the bottlenose dolphin *Tursiops truncatus*, the common porpoise *Phocaena phocaena*, the common dolphin *Delphinus delphis*, the striped dolphin *Lagenorhynchus obliquidens* and the Amazon River porpoise *Inia geoffrensis*. Evans (1973) presents a summary of the state of knowledge of echolocation by the small toothed whales.

ABSTRACTS OF RECENT DATA

Hydrophone arrays have been used to record repetative sound pulses of less than a few milliseconds duration from a fin, a humpback and a blue whale. The blue whale, temporarily entrapped by ice (Figure 1), emitted the acoustic signals into the water from the anterior portion of its 4 meter upper jaw. The front half of this jaw is devoid of air

cavities and moving muscles, hence it is unlikely that the sounds are produced there. This data, therefore, suggests that the upper jaw is an acoustic wave guide. These signals, recorded on three hydrophones at ranges 5-10 meters from the animal, as well as signals from the free swimming fin whale, recorded at ranges 10-20 meters from the animal, indicate the following peculiar directional property of the sounds. The low frequencies are beamed forward, the higher frequencies to the sides.

DISCUSSION

According to a comprehensive review of echolocation in marine mammals by Norris (1969) "It is highly probable that echolocation in some form is widespread, if not universal, among odontocete cetaceans". It should not then be surprising that this excellent method of detecting food and other targets in the ocean could be employed by the baleen whales as well. Let us review the evidence.

a) Including the recordings mentioned in this paper, fourteen instances of short repetitive acoustic pulses (small target 'echolocation-type' pulses) recorded in the presence of baleen whales have been studied by twelve investigators (Painter, 1963; Wenz, 1964; Gales, 1966; Perkins, 1966; Asa-Dorian and Perkins, 1967; Poulter, 1968; Winn *et al*, 1970; Beamish and Mitchell, 1971; Beamish and Mitchell, 1973 and Fish *et al*, 1974). All of the investigators felt that the circumstantial evidence strongly indicated that the baleen whales (mysticetes) and not toothed whales (odontocetes) were the authors of these sounds. In three cases, that of a Bryde's whale reported in Beamish and Mitchell, 1973, that of the Gray Whale (Fish *et al*, 1974) and that of the fin whale reported in this paper, the evidence is exceptionally strong. In one case, that of the blue whale entrapped by the ice, the acoustic data as well as the experience of studying the animal with a stethoscope (Figure 2), indicated conclusively that the whale was the author of the recorded sounds.

b) Mysticetes make loud low frequency sounds as reviewed by Schevill (1964), Evans (1967), Norris (1969) and Payne and Webb (1971). These signals have adequate acoustic properties to produce substantial echos from the surface and bottom of the ocean, in fact Payne and McVay (1971) note that humpback sounds are "invariably followed by trains of echos". It would be naive to believe that mysticetes cannot hear these low frequency sounds or that when the echo returns from the surface that they do not use the signal to determine range (especially because the animal needs to reach the surface before the time arrives for its next breath). This is not proof of echolocation because it does not demonstrate the dependence of performance upon the acoustic signal but it is strong evidence suggesting echolocation.

c) Evans (1973) lists species of odontocetes that are now known to use echolocation. Of all aquatic animals, mysticetes are more similar in life style to odontocetes than to any other group of animals; in fact these two suborders are often observed communicating in terms of interactions of a social nature.

d) Mysticetes have middle and inner ear structures similar to

those of odontocetes but substantially different from terrestial mammals (Fraser and Purves, 1960).

e) Many whalers have caused mysticetes to flee (presumably a fright reaction) in the presence of active sonar of the low ultrasonic frequencies.

The function of baleen whale sounds is not well known. Two possibilities are communication and "echointerpretation". However any cetacean sound may have more than a single function.

Echointerpretation is a method of learning about the characteristics of an object by analysing echoes from the object. Echo intensity which is a complicated function of output, transmission and target characteristics must be sufficient so that the echo can be recognized within the background ambient noise.

Once the echo is recognized the following information may be used.

a) pulse-echo time gives information about the range of the target.
b) echo direction together with pulse-echo time gives information about the location of the target, i.e. echolocation.
c) pulse-echo frequency shift gives information about the relative motion between the target and source.
d) repetitive echolocation also gives information about the relative motion between the target and source.
e) echo counting gives information about the density of the targets or biomass.
f) echo intensity gives information about target characteristics such as size, compressibility and density.
g) echo intensity and pulse-echo time may give information about the transmission medium characteristics.

Baleen whales are recalcitrant laboratory animals. Therefore it may be a long time before definitive experiments are performed to prove either their possible echolocation or the presence of higher orders of echointerpretation such as ability to measure zooplankton biomass. The usefulness of their evolved acoustic techniques to man can however be better and more quickly understood by means of definitive experimentation with man made active sonar. Let us therefore use the acoustic parameters of sounds recorded in the presence of cetaceans combined with the feeding and other behavioural characteristics of the animals to test acoustic echointerpretation techniques for quantitative zoogeographic studies of the oceans.

REFERENCES

Asa-Dorian, P.V. and P.J. Perkins (1967). The controversial production of sound by the California gray whale, *Eschrichtius gibbosus*. *Norsk Hvalfangsttid*, 56, (4), 74-77.

Backus, R.H. and W.E. Schevill (1966). *Physeter* clicks. *In*: Whales, Dolphins and Porpoises, (Ed. K.S. Norris). Univ. California Press, Berkeley and Los Angeles, 510-528.

Beamish, P. and E. Mitchell (1971). Ultrasonic sounds recorded in the presence of a blue whale *Balaenoptera musculus*. *Deep-Sea Res.*, 18,803-809.

Beamish, P. and E. Mitchell (1973). Short pulse length audio frequency sounds recorded in the presence of a Minke whale (*Balaenoptera acutorostrata*). *Deep-Sea Res.*, 20, 375-386.

Evans, W.E. (1967). Vocalization among marine mammals. *In: Marine bio-acoustics*, (Ed. W.N. Tavolga). Pergamon Press, 2, 159-186.

Evans, W.E. (1973). Echolocation by marine delphinids and one species of fresh-water dolphin. *J. Acoust. Soc. Am.*, 54(1), 191-197.

Fish, J.F., J.L. Sumich and G.L. Lingle (1974). Sounds produced by the Gray Whale *Eschrichtius robustus*. *Marine Fisheries Rev.*, 36(4), 38-45.

Fraser, F.C. and P.E. Purves (1960). Hearing in cetaceans. Bull. Brit. Mus. (Nat. Hist.), 7, 1-140.

Gales, R.S. (1966). Pickup, analysis and interpretation of underwater acoustic data. *In: Whales, Dolphins and Porpoises* (Ed. K.S. Norris), Univ. of California press, Berkeley and Los Angeles, 435-444.

Norris, K.S. (1969). The echolocation of marine mammals. *In: The biology of marine mammals*. (Ed. H.T. Andersen). Academic Press, 391-423.

Painter, D.W. II (1963). Ambient noise in a coastal lagoon. *J. Acoust. Soc. Am.*, 35(9), 1458-1459.

Payne, R. and D. Webb (1971). Orientation by means of long range acoustic signaling in baleen whales. *Ann. N.Y. Acad. Sci.*, 188, 110-142.

Payne, R. and S. McVay (1971). Songs of humpback whales. *Science*, 173, 587-597.

Perkins, P.J. (1966). Communication sounds of finback whales. *Norsk Hvalfangsttid.*, 55(10), 199-200.

Poulter, T.C. (1968). Vocalization of the gray whales in Laguna Ojo de Liebre (Scammon's Lagoon) Baja California, Mexico. *Norsk Hvalfangsttid.*, 57,(3), 53-62.

Schevill, W.E. (1964). Underwater sounds of cetaceans. *In: Marine bio-acoustics*, (Ed. W.N. Tavolga). Pergamon Press, 1, 307-316.

Wenz, G.M. (1964). Curious noises and the sonic environment in the ocean. *In: Marine bio-acoustics*, (Ed. W.N. Tavolga). Pergamon Press, 1, 101-119.

Winn, H.E., P.J. Perkins and T.C. Poulter (1970). Sounds of the Humpback Whale. Proc. 7th Ann. Conf. Biol. Sonar and Diving Mamm. Stanford Res. Inst., Menlo Park, Cal. 39-52.

Fig. 1 - Twenty-two meter Blue Whale temporarily entrapped by ice on the southwest coast of Newfoundland, March 21, 1974. The animal escaped before sunrise the following morning.

Fig. 2 - The use of a stethoscope to study heart beat and other acoustics of the live Blue Whale. The weight of the scientist had no observable effect on the behaviour of the animal.