REPORT ON SCOR-UNESCO INTERCALIBRATION TESTS CARRIED OUT ON VITYAZ 2-8 AUGUST 1962 IN CONNEXION WITH PRIMARY PRODUCTION INVESTIGATIONS IN THE INDIAN OCEAN

by

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The following is a preliminary and narrative report of work to carry out intercalibration for measurements of primary production in the Indian Ocean. While the efforts were relatively unsuccessful in so far as this goal was concerned, they were very successful in advancing the likelihood of the Indian Ocean productivity work being valuable and useful to others. A great deal of effort on the part of the crew and Soviet scientists aboard Vityaz helped us to obtain our results.

Those participants responsible for the productivity manipulations of a technical sort were:

Dr. Maxwell S. Doty, University of Hawaii, Honolulu 14, Hawaii, U.S.A., Chairman
Mr. Norman Dyson, C.S.I.R.O., P.O. Box 21, Cronulla, N.S.W., Australia
Mr. Harry Jitts, C.S.I.R.O., P.O. Box 21, Cronulla, N.S.W., Australia
Dr. Olga Koblentz-Mishke, Institute of Oceanology, Moscow, USSR
Dr. Yatsuke Saijo, Water Research Laboratory, Nagoya University, Japan.

Narrative journal of the sessions

Participants from Australia, Japan and the U.S.A. arrived in Perth on the evening of 29 July. However, the equipment for the tests was not fully assembled until 2 August, due to unsatisfactory transport arrangements.

Vityaz arrived in Fremantle on 31 July. 31 July to 2 August was spent in setting up equipment, discussing possible plans and in planning the operations at sea. Vityaz departed from Fremantle on the evening of 2 August and arrived on station on the morning of 3 August.

3 August All operations planned were attempted in order to test equipment and facilities. Considerable difficulty was encountered; e.g. the water supplies to the incubators were inadequate and time was lost in organizing the light measurements in the sampling procedures and in the launching of the drift buoy for the in situ measurements the weather was unfavourable. All participants were able to carry out some measurements but there were discrepancies of several hours in the times of commencement of incubation by the individual participants. The in situ measurement was not commenced until 15.15 hours.

4 August All work was abandoned due to unfavourable weather.

5 August In order to increase the probability of obtaining reliable results, the plan of operations was simplified by reducing it to measurements by each participant using his own techniques and in situ measurements using the Australian technique on aliquots of samples used by each participant. The USSR made measurements

on two aliquots of each sample used for the in situ measurement, using both USSR and Australian O^{14} stocks and filtration methods, but only USSR incubation. The major difficulties encountered were again water supplies and light measurements.

6 August To test for technique differences samples were collected before sunrise from 6 depths and two aliquots were inoculated by each participant using his own bottles and methods. These samples were resuspended on a buoy attached to the ship from sunrise to 14.00 at the depths from which they were collected. All measurements made on 5 August were repeated.

7 August All work done on 6 August was repeated. This concluded the tests at sea. The morning experiment was done by using a floating buoy instead of the attached buoy.

8 August Australia, Japan and the USSR continued the Geiger counting of samples collected during the tests. The U.S. planchets could not be counted with the equipment on hand. Discussions of the report of the meeting were commenced.

9 August Vityaz returned to Fremantle in the morning. Most of the day was spent in repacking and dispatching equipment, but some time was devoted to a continuation of the discussions. All participants left for Sydney late in the evening.

10 August Participants arrived in Sydney late in the morning. Discussions were continued in the evening.

11 August During the morning the Chairman prepared a rough draft of the preliminary report to SCOR by the participants. In the afternoon the participants considered the draft and preparation of the final draft was begun.

12 and 13 August The Chairman continued with preparation of the final draft of the report. The USSR participant left for Perth on the morning of the 12th. The Japanese and U.S. participants departed from Sydney on the 13th.

Tests done and special methods used by the groups

Australian Samples taken at depths where light was measured to be equivalent to that under the respective filter in the sun-lit incubator used. Nylon net filters used once and blue glass filters used each day.

Japanese Samples taken from per cent light depths and incubated in uniform fluorescent light (once) or, regularly, in sun-lit incubators surrounded by stainless steel screen neutral density filters.

Russian In situ and uniform neutrally-filtered light used for all depths. On some days included experimental work or paralleled in part that of other groups.

U.S.A. Nylon mesh neutral light filters used for samples from a set of light per cent depths. One set in 1058 Hawaii type incubator and one set in prototype sun-lit Indian Ocean incubator.

In situ Done at all depths used by individuals whenever their techniques were applied.

Treatment of data from tests

As Geiger counting of samples and processing of data from all participants were not possible, each participant has accepted the responsibility of completing these and sending copies of the data to the Chairman as soon as possible, but, before the end of September 1962. This data is to be assembled and distributed in the form of the attached table.

Statistical treatment of the data from the participants will be subject to the recommendations received by the Chairman from each participant after each has had an opportunity to study the distributed data. However, no such detailed analysis of the data as was forthcoming from the Honolulu meetings is expected of these Perth data.

Post-cruise session

The data and analytic reports of the Honolulu sessions were discussed and the results of these discussions served as a guide for this report. The several arduous post-session conferences led to the following analyses of the limitations and positive achievements of both the Honolulu and the Perth intercalibration sessions and the formulation of their reports.

LIMITATIONS

1. Failure or inadequacy of individual pieces of equipment, material and methods caused a few distressing losses of data.

2. Most of the techniques depended on light measurements. Some participants did not bring light measuring instruments and conditions were not suitable for the use of some of the instruments which were available.

3. Water supplies to the incubators and light measuring apparatus prevented work being consistent, or applied at all in some cases, for the first three days of the work period at sea.

4. Insufficient time was allowed for planning the detailed programme.

5. Insufficient a priori knowledge of shipboard operations and individual wishes, and physical services required, resulted in inadequate preparation.

6. The use of only one water-sampler and the wide difference in time of sampling resulted in wide differences in the period between sampling and incubation of samples for the different groups.

7. The techniques of only half the group involve measurement of the radio-activity of the samples at sea and the others did not, therefore, have their counting equipment on hand. One type of membrane filter, because of its curling and low activity, could be counted in neither counting system aboard. Thus the data from these trials could not be analysed during the post-session conferences.

8. The lack of light filter calibration and a standard acceptable method for this meant proper light depths were not sampled.

PARTICIPANT (e.g. **JAPAN**)

Date:_____ Time of sampling:_____ Method of incubation:_____ Page No.____ of____

C^{14} stock_____ Accepted activity:_____ cpm/ml. Counting method:_____ Background:_____ cpm

Depth		Incubation period		Raw count				Standardized count (cpm) minus background		Accepted	other treatments and comments
Meters	% light	Time in	Time out	Light bottle	Period	Dark bottle	Period	Light	Dark		

Method of dark correction if not same as on first sheet:

9. Lack of suitable practical experience in the carrying out of the complex co-operative operations required in these studies caused loss of much of the period of time at sea. As in normal oceanographic practice the first few stations are usually regarded as suspect, all but perhaps the last day's work, in thise case, must be viewed with caution.

10. Contact with the ship being largely through one of the four participants prevented that person from equal participation.

11. This, above, also applied to the person in charge of the intercalibration and, largely, prevented him from being in charge except in name.

12. At times work of the vessel other than for intercalibration interfered with the intercalibration work. This was a major reason some of the a priori shipboard plans were abandoned after the cruise was begun.

13. Shortage of time for preparation and, especially for the Honolulu trials, time on station.

14. All the studies (both cruises) were made in water masses which are suspected of being rather low in productivity. Each of the two was probably confined to but one water mass.

15. None of the experiments was repeated sufficiently to yield statistically significant results.

16. All Honolulu post-cruise discussions and recommendations were made in the absence of Soviet participants.

POSITIVE ACHIEVEMENTS

The useful results of the two intercalibration sessions number among them the following summary points.

1. These co-operative trials have, first, been splendid beginnings toward international co-operation in such studies and allowed the different workers to become familiar with each other's methods, thinking and opinions.

2. These trials demonstrated the need for further extensive studies on the methods for measuring light penetration, and possibly the advisability of adopting standard methods in this field.

3. The comparison of Geiger counting of the filters by the two methods of Hawaii and C.S.I.R.O. demonstrated that reliable intercalibration is possible. This shows the advisability of the adoption by all workers of "two-pi" Geiger counters of comparable efficiency, such as gas-flow counters.

4. There was general agreement at Perth that the general aim of the programme should be twofold: intercalibration to enable comparison of existing and future data, and also standardization on a universal method to be used in conjunction with the methods of the different individuals.

The determination of approximate coefficients for the interconversion of data from different workers possibly can be achieved by repeating similar work with much greater replication in different areas, comparing both in the laboratory and field specific techniques and the complete methods.

5. It was agreed that the in situ method is the most reliable technique for measuring relative primary productivity and this should be applied whenever possible.

6. Plans for achieving satisfactory intercalibration were formulated and implemented. The implementation is in the adoption of the in situ method as the reference method for Indian Ocean productivity measurement. Both are detailed below.

Desiderata and recommendations

1. It is recommended that the following procedures be encouraged in so far as productivity is concerned for the Indian Ocean. In some points the following are rather large departures from the recommendations made in Honolulu.

   (a) The in situ measurement of productivity should be used by all workers as a reference method and as a supplement to their individual programme. The results of such measurements will provide common reference or intercalibration values for the interrelating of the results from the different participant groups. This method should include the following details.

      (l) Sample depths must extend through the euphotic layer.

      (m) At least 5 depths must be sampled.

      (n) Enough depths should be included so that samples are no more than 10 meters apart.

      (o) The samples used for in situ experiments should be sub-samples of that used for the individual parallel programmes.

      (p) Attention must be paid to sampling water from the layers of phytoplankton accumulation discovered by the optical methods.

   (b) Sampling and light measurement should be done between 1000 and 1200, but as close to 1200 as possible. In situ incubation to obtain reference values should be from noon to sunset.

   (c) Water used should be from the same samples as are being sub-sampled for other measurements, such as for pigments, nutrient chemistry, seston, phytoplankton and especially for the reference value in situ measurements.

   (d) Non-metallic water samples should be used the material of which has been demonstrated to be non-toxic in so far as phytoplankton photosynthesis is concerned.

   (e) All radioactive stock solutions should be intercalibrated by one laboratory and should give about 10^7 cpm/ml with the counter to be used by the individual worker.

(f) The counting efficiency of the counting system used for measuring the radioactivity of productivity samples should be determined by a uniform procedure. Data reports should include corrected cpm of the dark and light bottles, cpm of the stock, sample time, "time in", "time out", total incubation time in hours (and decimal parts, not fractions), sampling depths in meters and per cent of surface light and position of sampling. The method of correction for dark counts must be described. (See "Data Report Form" in (b) above).

(g) Light must be studied as exhaustively as possible to provide information at least as detailed as would be provided by measurement of:

(l) Incident solar radiation This must be measured. Continuous daily recording is recommended.

(m) Light penetration, which must be measured. It is recommended that these measurements be in per cent as a function of depth. A minimal measure is Secchi disc depth in meters.

(n) Turbidity measurements as a function of depth are very desirable and recommended as a measure of the layering or vertical patchiness of the standing crop of (phyto-) plankton.

(h) Temperature as a function of depth should be recorded through the euphotic zone. The use of bathythermographs and the publication of the results as bathythermograms is recommended.

2. Reasons for abandonment of the proposed standard method of incubation

The discussion of the standard method proposed at Honolulu rapidly demonstrated that there were widely divergent opinions as to what the prerequisites of such a method were. Even more seriously there was a lack of comparable data from the different techniques counter-proposed, e.g. on neutral and coloured filters, their calibration, and the measurement of light depths for sampling.

In view of the above it was decided to recommend the abandonment of the proposed standard incubator and to recommend instead that all workers in the Indian Ocean make in situ measurements whenever possible. It was recognized that in situ measurements would not be made with sufficient frequency so as to give ocean-wide survey of productivity. Most workers would use other more convenient techniques, but as these are so diversified it was felt that it was more in the nature of research tasks for the individual workers to relate the measurements of the various methods to those made in situ. When this will have been done, the data from differing methods may be compared via use of the relationships of the different individual technique results to the reference value in situ results.

3. Suggestions to SCOR for the future

(a) It is recommended that members of this working group study in reference to the design and application of the individual national procedures for the Indian Ocean the following:

(i) Filters for simulating light conditions of the ocean.

(ii) The paper "Desiderata for the Perth, Australia, Primary Productivity meetings".

(iii) The paper "Analysis of the productivity data from the September, Honolulu, intercalibration trial".

(iv) The paper to be expected as a report based on the points in this preliminary report sent only to the President of SCOR and the national representatives for this productivity work, as well as the data which will be distributed from the Perth cruise.

(b) It is recommended that an extended meeting of the Indian Ocean productivity workers be planned that will provide an opportunity for comparing results of the individual attacks on the common problems such as those listed below here. This should be both for conference and experimental work, and could be during a ten-day period prior to another intercalibration cruise.

(i) Planchet washing with acid or sea water.

(ii) Dark bottle fixation in relation to its variability.

(iii) The large variability of surface values.

(iv) Filter pressure, rate (ml/min), and pore size.

(c) It is recommended that the President of SCOR ask the Indian Ocean productivity groups to prepare a plan for a prospectively fruitful intercalibration meeting and submit this to him for possible implementation. Such an event should embody the following:

(i) Intercalibration of light measuring devices used.

(ii) Intercalibration of light filters used.

(iii) Intercalibration of productivity measuring techniques.

(iv) Provision of time and facilities that will encourage satisfactory replication of the comparisons made so that confidence levels approach the 95 per cent level.

(v) Demonstrations of new equipment and their modifications.

(vi) Exchange and discussion of Indian Ocean results and plans.

(vii) A shipboard programme

1. Station time equal to perhaps 110 hours on station, actual calendar period uncertain but at least 15 days to allow for such as rough weather and accidents.

2. Carry out at least ten drift stations between dawn and dusk in as wide a range as possible of both productivities and latitudes.

3. Each participant group to work as a separate and self-contained unit, bringing or being supplied before the cruise with all the equipment or material required to carry out the operations planned for use in the Indian Ocean work. The ship should be regarded solely as a platform and as a source of e.g. electricity, running water and winches.

4. At each station each participant should individually carry out the following operations where any of them form part of his own plans for work in the Indian Ocean.

   (i) Measure directly in situ primary production in the water column down to the bottom of the euphotic layer. Perhaps only one in situ string could be used in common by all (see 5 below).

   (ii) Measure by indirect means in situ production in the water column using the method the individual favours.

   (iii) Measure the relative productivity of the water column at agreed standard and/or other depths using the incubation technique the individual proposes to use in the Indian Ocean.

   (iv) Measure other things such as phytoplankton pigments at the same depths as in (iii) above as the individual may want to do.

5. At each station, the participants should carry out a joint in situ measurement at fixed depths, i.e. selected a priori but NOT necessarily the same for all techniques, in the morning in the same way as at Honolulu to test for technique differences. A separate technician should do this, in so far as it is for the common good.

6. A common set of light measurements should be made for the intercalibration group by one technician. These should include the optical measurements recommended and requested elsewhere in this report.

7. Geiger counting should be done at sea so as to allow an early comparison of the results on return to the shore laboratory, though this may be in addition to some individual normal routines.

8. Planchets should be exchanged for intercalibration of Geiger counting following final evaluations by the group producing them.

(d) No meetings of any kind should be scheduled without adequate time for both pre and post-sessions. The post-sessions should continue until the raw data and report to the President of SCOR are completely drafted if possible.

(e) Assistance for statistical treatments should be provided both for design of experiments and analysis of the results from data-producing meetings.

4. It is respectfully requested that the President of SCOR execute the following:

(a) Have plans made for prospectively fruitful activities such as those recommended in 3 above.

(b) Obtain assurance of financing for the working groups' costs, e.g. either by expenses being paid by Unesco, the parent Organization of the individual participants or by grants from other sources.

(c) Arrange the availability of a convenient ship, which may be paid for by Unesco and a marine laboratory for preliminary and final discussion.