over a much wider area and time span in the same monsoon season. When it was used, the Engel II net caught more fish off Sarawak than the four-seam net in 1972, and appears to be more effective for fishing in this area; it was not tested in other areas. It is likely that the net will be experimentally tested in the near future.

The variation in the catch from haul to haul in the Tioman area was greater in 1971 than in 1972. Part of this was due to the poor catch of the first few practice hauls with the new boat and also partly due to the larger variation of catch of many more dominant fish categories, possibly as a consequence of differences in fish schooling behaviour.

5. ACKNOWLEDGEMENTS

Thanks are due to the Project Manager of Fisheries Training Centre, Singapore, and the Director of Primary Production, Singapore, for release of the data of the JURONG.

References
2. FISH STOCKS AND FISHERIES

2.1 Trawling Fisheries of Taiwan

There are three types of trawling fisheries in Taiwan:

1. Drag-net fishery: The trawler is below 50 tons. It has 2,480 netters weighing 42470.39 tons, landing 98685 mt. products in 1971*. The main fishing grounds are in Taiwan Strait.

2. Otter trawl fishery: The trawler is above 50 tons. It has 163 trawlers weighing 20235.22 tons, landing 56580 mt. products in 1971*. The main fishing grounds are around the East China Sea and Taiwan Strait.

3. Paired trawl fishery: The trawler is also above 50 tons. It has 317 trawlers weighing 39949.65 tons, landing 140814 mt. products in 1971. The main fishing grounds are around the South China Sea and the water surrounding Northern Australia.

2.2 Statistics of Taiwan Trawling Fisheries

The fishing ground of the South China Sea has been demarcated into seven regions with every unit block of half degree square. Every trawler of above 50 tons has been expected to turn in the log book report as the original reference after each voyage. These reports will then be collected by the field stations of Demersal Fish Research Center at Keelung and Kaohsiung fish market. In the log book information such as exact date, position of trawling, daily working haul number, and daily catches of each species have been recorded carefully. All of the collecte data have been well arranged to get effort and catch statistics by area. This work has been in progress since 1970. A more efficient systematic data processing system with computer routine will be set up.

2.3 Stocks assessments for exploited stock

Fishing effort, total catch, and unit catch of Taiwan paired trawling fishery in the South China Sea is shown in Table II. The annual changes of fishing effort of each major fishing ground from 1969 to 1971 shows a little increment in region 6,8,9, but a great increment in region 7, and on the contrary, a great decrement in region 3,4,5. Generally speaking, the fishing efforts decreased gradually in the northern neritic area of the South China Sea and relatively increased gradually in the southwest neritic area of the South China Sea. It indicates that some trawlers which operated in the northern neritic area of the South China Sea extended gradually more and more southward.

Comparing the yearly total fishing effort among different regions in 1971, it shows that region 3 hold they first position, 41% of the total. Following is region 7 with 22%, region 4 with 12%, region 5 with 10%, region 6 with 5%, region 9 with 5%, region 8 with 4%. The annual changes of total catches in each regions are proportional to the total fishing efforts expended. In region 3,4,5, there seems a decline in catch from year to year. On contrary, in region 6,7,8 and 9 reveal a increment in catch. Comparing the yearly total catch among different regions in 1971, it shows that region 3 hold the first position, 35% of total, region 7 with 26%, region 4 with 12%, region 5 with 10%, region 6 with 5%, region 9 with 5%, region 8 with 4%. The unit catch among these years in each regions shows a little variety. In comparing the unit catch among different regions in 1971, it shows that there are nearly same

* Adapted from Fisheries Yearbook of Taiwan Area 1971
Table II. Fishing effort, total catch, and unit catch of Taiwan paired trawling fishery in the South China Sea from 1969 – 1971.

<table>
<thead>
<tr>
<th>Region</th>
<th>Fishing effort (Haul)</th>
<th>Total catch (Cases*)</th>
<th>Unit catch (Cases per haul)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R3</td>
<td>95,021</td>
<td>78,932</td>
<td>65,790</td>
</tr>
<tr>
<td>R4</td>
<td>38,702</td>
<td>32,718</td>
<td>19,511</td>
</tr>
<tr>
<td>R5</td>
<td>24,482</td>
<td>29,130</td>
<td>16,482</td>
</tr>
<tr>
<td>R6</td>
<td>235</td>
<td>301</td>
<td>9,037</td>
</tr>
<tr>
<td>R7</td>
<td>11,710</td>
<td>23,103</td>
<td>34,453</td>
</tr>
<tr>
<td>R8</td>
<td>17</td>
<td>516</td>
<td>6,512</td>
</tr>
<tr>
<td>R9</td>
<td>115</td>
<td>3,020</td>
<td>7,094</td>
</tr>
</tbody>
</table>

* One case is 26 kg

In region 4, the main species are: golden thread, *Nemipterus mesoprion* (sp. no. 24); golden thread, *Nemipterus virgatus* (sp. no. 20); big-eye, (sp. no. 1); lizard fish, (sp. no. 8); golden thread, *Nemipterus flaviventris* (sp. no. 14); etc.

In region 5 they are: red mullet, *Upeneus bensasi*, (sp. no. 2); yellow sea bream, *Dentex tumifrons* (sp. no. 22); lizard fish, (sp. no. 8); malabar snapper, *Lutjanus malabaricus* (sp. no. 6); big-eye; golden thread (sp. no. 20); etc.

In region 6, they are: big-eye; lizard fish, *Saurida elongatus*, (sp. no. 9); sea catfish, *Ariidae spp.* (sp. no. 4); golden thread (sp. no. 14); malabar snapper (sp. no. 6); etc.

In region 7, they are: lizard fish, *Saurida undosquamis*, (sp. no. 7); cuttle fish (sp. no. 5); golden thread, *Nemipterus marginatus*, (sp. no. 15); big-eye; common squid, *Loligo spp.* (sp. no. 12); etc.

In region 8, they are: big-eye; red mullet (sp. no. 2); lizard fish (sp. no. 9—); sea catfish (sp. no. 4); amberfish, *Decapterus maruadsi* (sp. no. 10); malabar snapper (sp. no. 6); etc.

In region 9, they are: sea catfish (sp. no. 4); golden thread, *Nemipterus nemurus*, (sp. no. 18); pompanos, *Caranx equula*, (sp. no. 11); lizard fish (sp. no. 7); big-eye; red snapper (sp. no. 6); red-mullet (sp. no. 2); etc.

In order to compare the similarities in species composition.

Table III. Estimated demersal resources of the South China Sea

<table>
<thead>
<tr>
<th>Region</th>
<th>Area km²</th>
<th>Density cases/haul</th>
<th>Density cases/ha</th>
<th>Density kg/ha</th>
<th>Density Standing stock (000 tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R3</td>
<td>131,000</td>
<td>16.3</td>
<td>1.5</td>
<td>39</td>
<td>511</td>
</tr>
<tr>
<td>R4</td>
<td>217,000</td>
<td>17.3</td>
<td>1.5</td>
<td>39</td>
<td>846</td>
</tr>
<tr>
<td>R5</td>
<td>202,000</td>
<td>17.8</td>
<td>1.6</td>
<td>42</td>
<td>840</td>
</tr>
<tr>
<td>R6</td>
<td>332,000</td>
<td>21.3</td>
<td>1.9</td>
<td>49</td>
<td>1,640</td>
</tr>
<tr>
<td>R7</td>
<td>245,000</td>
<td>26.2</td>
<td>2.3</td>
<td>60</td>
<td>1,465</td>
</tr>
<tr>
<td>R8</td>
<td>378,000</td>
<td>24.9</td>
<td>2.2</td>
<td>57</td>
<td>2,162</td>
</tr>
<tr>
<td>R9</td>
<td>249,000</td>
<td>31.2</td>
<td>2.8</td>
<td>73</td>
<td>1,813</td>
</tr>
<tr>
<td>Total</td>
<td>1,754,000</td>
<td></td>
<td></td>
<td></td>
<td>9,227</td>
</tr>
</tbody>
</table>
Fig. 4 Values of unit catch and species composition of eight different regions.
*Unit Catch = cases/haul  1 case = 26 kg.

2.5 The seasonal variations of catch and species composition

2.5.1 The seasonal variation of unit catch of each species

The seasonal change of the species in unit catch are shown in figure 6-a and 6-b.

The cuttle fish (sp. no. 5) reveals an almost identical seasonal fluctuation patterns in all regions: The maximum yield seasons from Oct. to Mar. and minimum in summer time.

Common squid (sp. no. 12) abundant in autumn in all regions.

Hair-tail (sp. no. 3) most abundant in north region (region 3) in winter and spring time, in region 7 it is abundant in autumn.

All the other species and the other miscellaneous species show no significant seasonal changes. The total unit catches also show no significant seasonal changes.

2.5.2 The seasonal variation of species composition

In order to clarify the seasonal change of species composition the Spearman’s rank correlation coefficient are arranged by successive seasons in each region, as shown in figure 7.

The curves between A and B seasons and between C and D seasons in each region show same resemblance tendency, but between A, B and C, D seasons they show a little difference. Therefore, there are a few seasonal change in species composition in each region.

3. SUMMARY AND DISCUSSION

The general bottom sediments of the areas are as follows:
Taiwan Strait: sand, with rocks around Penghu islands.
South of Hong Kong: mud, with rocks.
Gulf of Tonking: mud
South Vietnam coast: sand, with rocks on the narrow shelf off Vietnam.
Gulf of Thailand: mud
Between South Malay Peninsula and Borneo: mud, with rocks around Natuna islands.

All of these areas, except the inner part of the Gulf of Thailand and the Gulf of Tonking, have been operated by Taiwan paired trawlers. The workable trawling areas evidently are those of sandy and muddy areas.
**Fig. 6a** The seasonal changes of unit catch of each species.

**Fig. 6b** The seasonal changes of unit catch of each species. (continued)

**Fig. 7** Series of rank correlation coefficients obtained from four successive seasons.

The species compositions reveal more or less differences among different regions. However, the geographically nearby areas reveal some similarities among them. They also reveal a great diversity of species without any being really dominant and a little seasonal change in species composition in each region. Most presently used population dynamics models, and management practices, were typically developed for individual temperate water species, often long lived. So attention should be focussed on preparing modes on a multi-species or community basis.

**Reference**


