Fishery Technology 50 (2013) : 219 - 224

Performance of Sieve net Bycatch Reduction Devices in the Seas off Cochin (Southwest Coast), India

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Abstract

Bottom trawling is widely employed for catching shrimps in India. Due to the multi species nature of Indian fisheries, bottom trawling catches considerable amount of non-shrimp resources, especially juveniles. Performance of two designs of Sieve net Bycatch Reduction Devices was evaluated in the seas off Cochin, southwest coast of India. Designs selected were Sieve net (i) with a 60 mm diamond mesh funnel inside the net and 80 mm diamond mesh outlet codend (Sieve net-60) and (ii) with 50 mm diamond mesh funnel inside the net with 60 mm diamond mesh outlet codend (Sieve net-50). Among the two Sieve nets evaluated, Sieve net-60 performed better in terms of shrimp retention. Bycatch exclusion in Sieve net-60 was about 37% (without jellyfish) and 15% (with jellyfish) while bycatch exclusion in Sieve net-50 operated during non-jelly fish season was 33%. Shrimp loss was 4.5% and 19.5% in Sieve net-60 and Sieve net-50, respectively. Marketable size groups of fishes and crabs were retained in outlet codends of the Sieve net BRDs. Sieve nets can also be efficiently used to exclude jellyfish when they are abound in the shrimp fishing grounds, by keeping the outlet codend open. Sieve net-60 has potential for adoption in tropical trawl fisheries, in order to minimize the impact of shrimp trawling on juveniles and non-targeted species.

Keywords: Trawling, bycatch, discards, bycatch reduction devices, sieve net BRD

Received 21 June 2012; Revised 09 March 2013; Accepted 05 June 2013

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Introduction

Bottom trawling, which is known to be the most effective method for shrimp capture, is widely accepted in the world. During shrimp trawling, large quantities of finfish bycatch including significant amount of juveniles are also caught. The term bycatch means that portion of catch other than target species caught while fishing, which are either retained or discarded (Alverson et al., 1994). Average annual global discards, has been estimated to be 7.3 million t, based on a weighted discard rate of 8%, during 1992-2001 period (Kelleher, 2004). Trawl fisheries for shrimp and demersal finfish account for over 50% of the total estimated global discards (Kelleher, 2004). According to Davies et al. (2009) "bycatch is the catch that is either unused or unmanaged" and estimated the global marine fisheries bycatch as 40.3 million t based on the new definition.

In India, the bycatch problem is acute due to the multi-species nature of the fisheries. Kelleher (2004) has estimated total bycatch discards in Indian fisheries at 57 917 t, which formed 2.03% of the total landings. The discarded quantity of bycatch along Kerala coast estimated during 2000-2001 was 2 62 000 t and during 2001-2002 it was 2 25 000 t (Kurup et al., 2003). The dominant varieties among the discards were finfishes, crabs and stomatopods (Kurup et al., 2003; 2004).

Sieve net is a large mesh funnel fixed inside the net which guides the fish to a second codend with large diamond mesh netting, while shrimps pass through large meshes and accumulate in the main codend (Polet et al., 2004; Boopendranath et al., 2008; 2010; Sabu, 2008). Sieve nets (also known as veil nets) without outlet codend is made mandatory under EU legislation in European brown shrimp fisheries (CEFAS, 2003). Sieve net is used in commercial shrimp fleets of the Netherlands, UK, France, Germany, Denmark and Belgium (Polet et al., 2004).

Sieve net was found to be the most effective trawl modification which reduced discard levels of juvenile fish and shrimps and was recommended for mandatory use in beam trawls in UK (Revill et al., 1999; Revill & Holst, 2004). The present study was an attempt to study the bycatch reduction technologies suitable for the Indian subcontinent.

Materials and Methods

Fishing area, vessels and trawls

The experimental trials were carried out during September to December 2006 and March 2007 from a 17.5 m L_{OA} trawler (57.17 GRT; 277 hp @ 1000 rpm Kirloskar Mann engine) and a 15.24 m L_{OA} trawler (30 GRT, 223 hp @ 1800 rpm Ruston MWM engine), the research vessels of Central Institute of Fisheries Technology, Cochin (India). The experimental fishing operations were conducted during daytime, in the traditional shrimp fishing grounds at depths ranging between 9 and 32 m in the seas off Cochin, Southwest coast of India (Fig. 1). The Sieve net was attached to the body of a commercial shrimp trawl of 32.4 m rigged with V-type steel otter boards of 1420x790 mm size (80 kg each) and 20 m double bridles. The net was made of knotted polyethylene (PE) netting with mesh size of 50 mm in the front part and decreasing to 30 mm in the aft part of the net. The codend made of knotted PE netting of 20 mm mesh size was provided with a protective cover made of 120 mm mesh size and 3 mm dia PE netting.

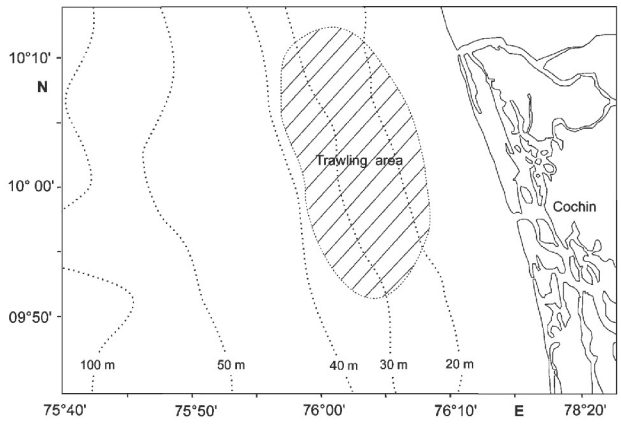


Fig. 1. Map showing the fishing area

Sieve net design

Designs of bycatch reduction device (BRD) included Sieve net (i) with 60 mm diamond mesh funnel inside the net and 80 mm diamond mesh outlet codend (Sieve net-60) and (ii) with 50 mm diamond mesh funnel inside the net and 60 mm diamond mesh outlet codend (Sieve net-50) (Fig. 2). In Sieve net-60, a funnel made of 60 mm mesh netting (135 meshes in circumference in the leading edge, 19 meshes in circumference in the hind edge and 70 meshes in depth) was used for separation of shrimps. The hind end of the funnel is opening to an outlet codend with 80 mm mesh size, of 4 m length and 60 meshes in circumference. In Sieve net-50, a 50 mm mesh funnel (162 meshes in circumference in the leading edge, 22 meshes in circumference in the hind edge and 84 meshes in depth) was used. The hind end of the funnel opened to an outlet codend of 4 m length and 70 meshes in circumference, fabricated out of 60 mm mesh netting. The outlet codend of the experimental Sieve nets was provided with small mesh (12 mm) cover (Fig.2) which was 2.5 times the dimensions of the outlet codend in order to retain the excluded catch (Sparre et al., 1989; Wileman et al., 1996; CIFT, 2003).

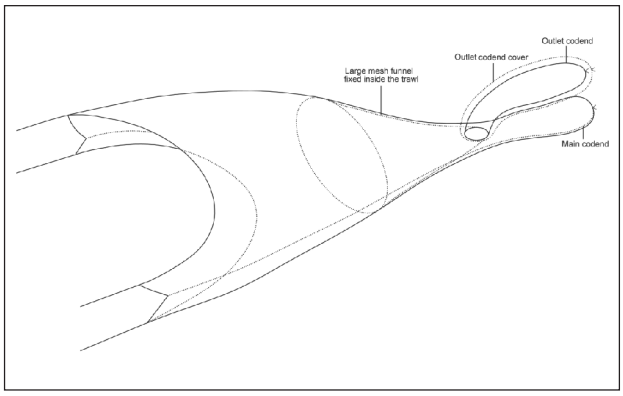


Fig. 2. Perspective view of Sieve net BRD installed in the trawl net

Data collection and analysis

Both retained and excluded catches from each haul were sorted, identified up to species level using Fischer & Bianchi (1984); Roper et al. (1984) and Froese & Pauly (2013) and length statistics were collected, to determine bycatch exclusion characteristics of the BRDs. In the case of large volumes of catch, a sub-sample weighing not less than 20% of the total weight was taken for measurements and scaled-up for analysis. Total length (TL), mantle length (ML) and carapace length (CL) were measured to the nearest mm, in the case of fishes and shrimps, cephalopods and crabs, respectively. Results from 34 hauls of 1 to 1.5 h duration with an

average towing speed of 2.5 knots were used for the analysis.

Results and Discussion

A total catch of 244.4 kg with a CPUE of 13.3 kg h^{-1} was obtained from 18 hauls using Sieve net-60 while 56.6% was contributed by jellyfish. Out of the total catch, 28.52% was retained in the main codend, 57.25% in the 80 mm diamond mesh outlet codend and 14.23% was excluded. Jellyfish formed a dominant component of the trawl catch from experimental operations. Out of 138.3 kg of jellyfish caught, 98.19% was diverted and retained in the outlet codend leading from the Sieve net funnel and only 1.8% reached the main codend (Table 1).

Analysis excluding jellyfish, which is of a seasonal occurrence in the trawl catch, has shown that out of the total catch of 106.1 kg with a CPUE of 5.77 kg h^{-1}, 63.33% was retained in the main codend, 3.89% in the outlet codend and 32.78% excluded through the large meshes of the outlet codend. The excluded bycatch (catch other than shrimps) from this BRD was 36.45% (mostly juveniles of fishes) of total catch and excluded shrimp catch was 4.47%. The overall catch during this period consisted of 47 species of finfishes, 5 species of shrimps, 2 species of crabs, 1 species of cephalopod, 2 species of elasmobranchs, 2 species of molluscan shells, 1 species of stomatopod and 1 species of jellyfish.

In the 80 mm outlet codend, 15 species were retained including 11 species of finfishes, one species of elasmobranch, one species of cephalopod, one species of crab and one species of jellyfish. Four species *viz., Pampus argenteus, Caranx ignobilis, Charybdis feriatus* and one ray species showed 100% retention in the outlet codend. Target catch *viz., Parapenaeopsis stylifera* and *Metapenaeus dobsoni* were retained in main codend at the rate of 99.10% and 95.84%, respectively.

A total catch of 290.03 kg with a CPUE of 17.58 kg h^{-1} was obtained from 16 hauls using Sieve net-50, of which 60.65% was retained in the main codend, 9.80% in the outlet codend and 29.55% predominantly consisting of juveniles were excluded (Fig 3

Table 1. Results of Sieve net installed trawl operations

	Sieve net-60		Sieve net-50
	Excluding jellyfish	Including jellyfish	
No. of hauls	18		16
Total catch (kg)	106.10	244.40	290.03
CPUE (kg h^{-1})	5.77	13.30	17.58
Retained catch in main codend (%)	63.33	28.52	60.65
Retained catch in outlet codend (%)	3.89	57.25	9.80
Excluded catch (%)	32.78	14.23	29.55
Total shrimp catch (kg)	12.17	12.17	75.64
Retained shrimp catch (%)	95.53	95.53	80.48
Excluded shrimp catch (%)	4.47	4.47	19.52
Bycatch (catch other than shrimps) (kg)	93.93	232.23	214.39
Retained bycatch (%)	63.55	85.26	66.91
Excluded bycatch (%)	36.45	14.74	33.09
Species encountered (No.)	60	61	81
Fish species (No.)	47	47	62
Shrimp species (No.)	5	5	6
Other species (No.)	7	8	13
100% exclusion (No.)	2	2	12
>50% exclusion (No.)	12	12	19
Up to 50% exclusion (No.)	28	29	33
0% exclusion (No.)	18	18	17

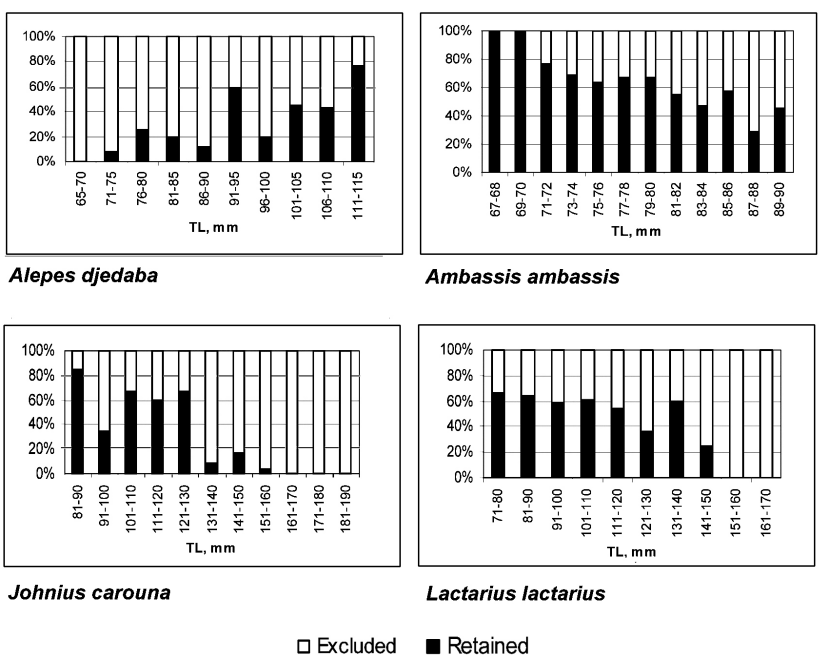
to 4). The overall catch during this period consisted of 62 species of finfishes, six species of shrimps, five species of crabs, two species of cephalopod, five species of molluscan shells and one species of stomatopod. Excluded bycatch (catch other than shrimp) was 33.09% of total catch and shrimp loss was 19.52% (Table 1).

In the 60 mm outlet codend, four species *viz., Charybdis lucifera, Charybdis feriatus, Carangoides armatus* and *Upeneus sulphurus* were fully retained. Seven species *viz., Portunus pelagicus, Portunus sanguinolentus, Mene maculata, Leiognathus brevirostris, Nemipterus japonicus, Saurida undosquamis* and *Dolcia ovis* showed more than 50% exclusion and out of a total of 50 species encountered in outlet codend, 39 species showed retention up to 50%.

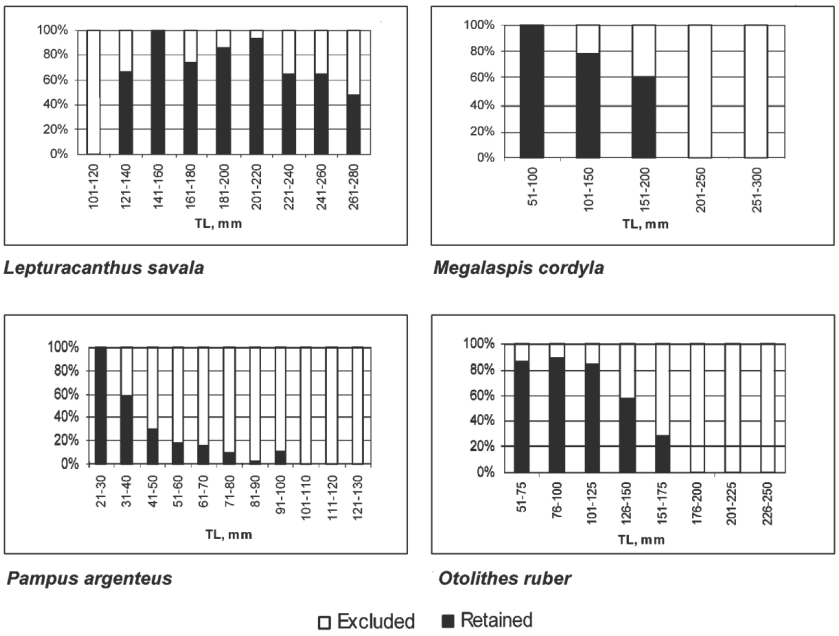
The Sieve net-50 excluded more than 90% of gastropod bycatch and more than 70% of squilla (*Oratosquilla* sp.) bycatch. However, target catch loss from this Sieve net design was higher (19.52%). Percentage loss was observed to be high for all shrimp species *viz., Metapenaeus dobsoni* (16.92%), *Parapenaeopsis stylifera* (42.17%), *Metapenaeus monoceros* (35.53%) and *Metapenaeus affinis* (59.07%) indicating that 50 mm mesh size in the Sieve net funnel is inadequate for allowing the shrimps to the main codend.

Length-wise retention and exclusion rates in respect of species, *Alepes djedaba, Ambassis ambassis, Johnius carouna* and *Lactarius lactarius* in Sieve net-60 installed trawl are given in Fig. 3. In the case of *Alepes djedaba*, length class 65-70 mm was fully excluded and length classes from 71 to 115 mm were retained in the range of 8 to 74%. Length class 67-70 mm in respect of *Ambassis ambassis* was fully retained and length classes from 71 to 90 mm showed an increasing trend in exclusion rate from 25 to 70%. Length classes of *Johnius carouna* from 81 to 130 mm were retained at the rate of 35 to 85%, length classes from 131 to 160 mm were excluded at rates in excess of 80% and length classes from 161 to 190 mm were fully excluded. *Lactarius lactarius* of length classes from 71 to 150 mm showed an increasing trend in exclusion rate ranging from 35 to 76% and length classes from 151 to 170 mm showed 100% exclusion.

In Sieve net-50, length-wise retention and exclusion characteristics in respect of four species *viz., Lepturacanthus savala, Megalaspis cordyla, Pampus argenteus* and *Otolithes ruber* are given in Fig. 4. Length class of 101-120 mm of *Lepturacanthus savala* showed 100% exclusion; 141-160 mm length class showed full retention and length classes from 161 to 280 mm showed retention in the range of 43 to



Fg. 3. Length-wise retention and exclusion of selected species from Sieve net-60



Fg. 4. Length-wise retention and exclusion of selected species from Sieve net-50

96%. *Megalaspis cordyla* in the length class of 51-100 mm was fully excluded and there was an increasing trend in the exclusion of length classes from 101 to 300 mm. Length classes of *Otolithes ruber* from 51 to 175 mm showed an increasing trend in exclusion rate from 10 to 70% and length classes from 176 to 250 mm were fully excluded. *Pampus argenteus* in the length class 21-30 mm was fully retained, length classes from 31 to 100 mm showed an increasing trend in exclusion rate in the range of 41 to 98% and length classes from 101 to 130 mm showed 100% exclusion.

Sieve net was found to be an effective design for the reduction of fish bycatch in different waters of the world. Polet et al. (2004) made Sieve net experiments in Belgium brown shrimp fishery using the commercial version of Sieve net design. The funnel having a mesh size of 70 mm and an outlet codend with mesh size of 80 mm provide escapement opportunity for juveniles, small fishes and invertebrates. Experiments using Sieve net in Belgium fishery has shown bycatch exclusion rates of 29-50% in different seasons, with less than 15% loss of shrimps. It is less effective in saving fishes less than 10 cm (Polet et al., 2004). Four designs of Sieve nets were evaluated by Revill et al. (1999) in commercial shrimp (*Crangon crangon*) beam trawling. During the evaluation, Sieve net was found to be the most effective trawl modification which reduced discard levels of juvenile fish and shrimp. Sieve net reduced small shrimp (*Crangon crangon*) to the tune of 29% by weight and was recommended for mandatory use in beam trawls in UK (Revill et al., 1999; Revill & Holst, 2004). CEFAS (2003) reported the use of a cone shaped large mesh netting with bottom opening known as veil net, which is similar in operational principle to Sieve net. This device reduced the retention of juvenile fish and invertebrates in the trawls and CEFAS (2003) recommended this technology for use in other fisheries.

Complete exclusion of bycatch from shrimp trawls may not be always acceptable to the fishermen, as a part of the bycatch constituted by large marketable species often contribute to the profitability of trawl operations in the tropical fisheries. Sieve net designs which are appropriately adapted to regional fisheries in terms of mesh sizes of the outlet and main codends, is expected to be acceptable and could lead to significant reduction in the mortality of juveniles during shrimp trawling. Sieve net-50 (50 mm diamond mesh funnel and outlet codend of 60 mm mesh size) has functioned poorly in terms of target catch retention which was only about 80%, making this design unacceptable for commercial use. Sieve net-60 with 60 mm diamond mesh funnel inside the net and 80 mm diamond mesh outlet codend, has been able to exclude substantial quantities of bycatch including juveniles while keeping shrimp

loss at about 4.5% and retaining larger marketable bycatch species. In addition, it is also possible to adapt the Sieve net to retain the shrimp catch and efficiently exclude jellyfish when they are abound in the shrimp fishing grounds, by keeping the outlet codend open. Trawl fishermen can thus reduce the sorting time onboard resulting in an increase in the useful fishing time and can enhance the profitability of trawl operations. Sieve net-60 has potential for adoption in tropical trawl fisheries, in order to minimize the impact of shrimp trawling on juveniles and non-targeted bycatch species.

Acknowledgements

The authors wish to thank the Director, Central Institute of Fisheries Technology for providing the facilities to conduct the studies. This work was done under the Indian Council of Agricultural Research (ICAR) Ad-hoc Project entitled *'Bycatch Reduction Devices for Selective Shrimp Trawling'*.

References

Alverson, D. L., Freeberg, M. H., Murawski, S. A. and Pope. J. G. (1994) A Global assessment of fisheries bycatch and discards. 233 p, FAO Fish. Tech. Pap. No 339, Rome

Boopendranath, M. R., Pravin, P., Gibinkumar, T. R. and Sabu S. (2008) Bycatch reduction devices for selective shrimp trawling. ICAR Ad hoc Project Report, 220 p, CIFT, Cochin

Boopendranath, M. R., Sabu S., Gibinkumar, T. R. and Pravin, P. (2010) Soft bycatch reduction devices for bottom trawls: A review. Fish. Technol. 47: 99-110

CEFAS (2003) A study on the consequences of technological innovation in the capture fishing industry and the likely effects upon environmental impacts, Final report. 133 p, Royal commission on environmental pollution

CIFT (2003) CIFT-TED for Turtle–safe Trawl Fisheries - A Success Story in Responsible Fishing, CIFT Special Bulletin 12. 40 p, Central Institute of Fisheries Technology, Cochin

CMFRI (2010) Annual Report 2009-2010. 169 p, Central Marine Fisheries Research Institute, Cochin

Davies, R.W.D., Cripps, S. J., Nickson, A. and Porter, G. (2009) Defining and estimating global marine fisheries bycatch, Mar. Policy 33: 661-672

Fischer, W. and Bianchi, G. (1984) FAO species identification sheets for fishery purposes. Western Indian Ocean (Fishing Area 51). Prepared and printed with the support of the Danish International Devel-opment Agency (DANIDA), Rome; Food and Agricul-ture Organization of the United Nations, Vols. 1-6

Froese, R. and Pauly, D. (2013) FishBase. World Wide Web electronic publication. www.fishbase.org, version (Accessed 04 September 2006)

Kelleher, K. (2004) Discards in the World's Marine Fisheries: An Update, FAO Fisheries Technical Paper No. 470, FAO, Rome

Kurup, B.M., Premlal, P., Thomas, J.V. and Anand, V. (2003) Bottom trawl discards along Kerala coast: A case study. J. Mar. biol. Ass. India 45(1): 99-107

Kurup, B.M., Premlal. P., Thomas, J.V. and Anand, V. (2004) Status of epifaunal component in the bottom trawl discards along Kerala coast (South India) Fish. Technol. 41(2): 101-108

Polet, H., Coenjaerts, J. and Verschoore, R. (2004) Evaluation of the sieve net as a selectivity-improving device in the Belgian brown shrimp (*Crangon crangon*) fishery. Fish. Res. 69: 35-48

Revill, A., Pascoe, S., Radcliffe, C., Riemann, S., Redant, F., Polet, H., Damm, U., Neudecker, T., Kristensen, P. and Jensen, D. (1999) The economic and biological consequences of discarding in the European Crangon fisheries, Final Report to the European Commission, Contract No. 97/SE/025

Revill, A. and Holst, R. (2004) The selective properties of sieve net, Fish. Res. 66: 171-183

Roper, C. F . E., Sweeney, M. J. and Nauen, C. E. (1984) FAO Species Catalogue. Vol 3. Cephalopods of the World. An annotated and illustrated catalogue of species of interest to fisheries. FAO Fish. Synop. 125(3): 277

Sabu, S. (2008) Studies on soft bycatch reduction devices for trawling. 208 p, Cochin University of Science and Technology, Cochin

Sparre, P., Ursin, E. and Venema, S.C. (1989) Introduction to tropical fish stock assessment, Manual Part 1. FAO Fisheries Technical Paper Number 306 (1). 337 p, FAO, Rome

Wileman, D.A., Ferro, R.S.T. Fonteyne, R. and Millar, R.B. (1996) Manual of Methods of Measuring the Selectivity of Towed Fishing Gears, ICES Cooperative Research Report 215: 126