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4. A novel electronarcosis method to anaesthetize adult sturgeon in the river during surgical implantation of acoustic tags

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Abstract: Migration and behavioral studies conducted on large fish species often imply electronarcosis and tagging activities. Even if individuals are anaesthetized, tagging operations require considerable handling efforts and, moreover, the likelihood of inducing stress, which usually affects the individual's fitness, or even injuries, is proportional to body size. To decrease stress and the likelihood of injuries to large fishes during tagging operations as much as possible, it was developed a novel system that involves an electronarcosis device coupled with a handling tube. This system was designed and tested in 2009 by the DDNI and had as a result a significantly decreases of the time required for conducting the tagging operation for more than 50 adult sturgeons of different species (sterlet, stellate sturgeon, beluga sturgeon and Russian sturgeon).

Keywords: electronarcosis operating tube, large fish tagging, sturgeon, handling

INTRODUCTION

Sturgeon species (family *Acipenseridae*) are threatened globally due to habitat destruction, pollution, and over fishing (Paraschiv et al., 2006; Rosten et al., 2012). The wild sturgeons are still naturally spawning in the Lower Danube River, but all four anadromous sturgeon species are critically endangered accordingly IUCN Red List of Threatened Species (Otel, 2007). Since 1997, the Sturgeon Research Group (SGR) from Danube Delta National Institute (DDNI) has been involved in conservation and sustainable exploitation of wild sturgeon stocks.

To achieve that, different strategies and projects were developed to study the bio-ecology of sturgeons. Handling sturgeons to collect data often causes physical damage and stress to the fish. Before this novel method, usually tricaine methanesulfonate (MS-222) was used on the Danube River for temporary immobilization of various sturgeon species at different ages. The constraints associated with chemical sedatives led to the development of a new method for anesthetizing fish in the field (Constantinescu and Suciu, 1991). Electronarcosis is a technique that produces unconsciousness using electrical power (Massion and Downs, 1969). Early studies were conducted to observe the effects of this type of narcosis on fish using a constant direct current (Knutson 1954). Electronarcosis proved to be a better alternative to chemical anesthesia because it uses varying electrical frequencies to rapidly anesthetize fish and allows gentle recovery.

The benefits of electronarcosis include less handling and shorter recovery time, low risk of mortality, no visible sub-lethal effects (swimming and breathing behavior appear normal, no grossly apparent burns) (Henyey et al., 2002) and currents used are imperceptible to researchers that are handling the fish (Damon et al., 2010). Surgical implantation of internal transmitters should only be conducted on sturgeons that are in excellent condition, at times and when they are not stressed by fishing gear or fishermen. It is also well known that sturgeons are highly sensitive to handling; after implantation of acoustic transmitters, many stellate Sturgeons stopped their migration and swam back to the sea (Kynard et al., 2002). The portability and effectiveness of electronarcosis allows implantation of acoustic transmitters into a sturgeon's body cavity and tracking the fish along their spawning migratory routes. Despite the portability

and effectiveness of electronarcosis devices, tagging operations require considerable handling efforts, even when individuals are anaesthetized, and, moreover, the likelihood of inducing stress, which usually affects the individual's fitness or even injuries, is proportional to body size. To decrease stress and the likelihood of injuries to large fishes during tagging operations as much as possible, we developed a novel system that involves less handling effort and significantly decreases the time required for conducting the tagging operation.

MATERIAL AND METHODS

The system design started from the need for a simpler, faster and less stressful method with direct applicability in the river, to anaesthetize adult sturgeons during the surgical implantation of acoustic tags. The system blueprints were drawn to involve the simplest and most effective construction method, with easily acquired and cost-effective materials.

Adult sturgeons were captured on the Borcea branch and at rkm 800 - 863 of the Danube, using special trammel nets with 140-170 mm mesh size. Local fishermen from the area were sub-contracted to capture live sturgeons with a special fishing license issued by NAFA Bucharest.
The electronarcosis device is powered by a 12V car battery. The unit box is composed of a voltage inverter which transforms 12V DC to 40V AC and, using a regulator, output voltage can be adjusted between 0 and 35 volts DC indicated by a digital voltmeter.

RESULTS AND DISCUSSION

Before the use of an electronarcosis tube was introduced, sturgeons were tranquilized with MS-222 or by electronarcosis in a tank. Both those methods required removing the fish from the river and placing it in a tank where it was anesthetized. Transporting the fish from the river to the tranquilizing tank significantly increased handling time and stress. The new system, an electronarcosis device coupled with an operating tube, was successfully tested and used by the DDNI to reduce the handling stress in adult sturgeons (sterlet, stellate sturgeon, beluga sturgeon and Russian sturgeon).

A complete description of the required materials and operation steps involved in adult sturgeon anesthesia, in the river, during surgical implantation of acoustic tags is presented in **Textbox 1**. The electronarcosis tube has a window (hatch) in the middle that allows access to the sturgeon for handling and tagging. During surgery, the tube is half-submerged in the river and is attached to the boat with 2 or 3 straps. The electrodes are made of stainless steel plates. Small holes (Ø 10mm) form a sieve-like structure which allows almost natural water flow through the holding tube. The electrodes are placed into slots at both ends of the tube. Electrode plates are connected by insulated cables to the positive and negative poles of the electronarcosis device. This is an inverter with 12 V DC input / 0 - 35 V DC output with a digital voltmeter and a potentiometer. For surgical implantation of acoustic transmitters, fish were tranquilized using a system able to produce up to 35 V DC using a potentiometer and a digital voltmeter.

The surgical staff must include two persons: one to perform the surgery and one to assist by holding the fish and monitoring its vital signs. This electronarcosis method was used to implant acoustic transmitters and release operated sturgeons as soon as possible. Quick release of the fish is the key to avoid critically influencing the native behavior of wild sturgeons.

The system design to anaesthetize adult sturgeon in the river during surgical implantation of acoustic tags

The required materials, the operation setup and system scheme are presented below. The letters from the system scheme correspond to the ones used in the required materials section.

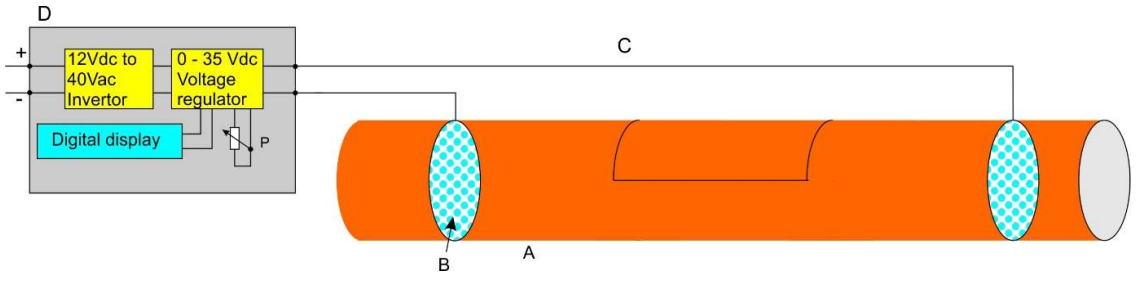
Required materials

A. Operating tubes made from PVC are used to keep sturgeons in a limited space. There are two types of tubes, depending on the size of the fish: a smaller tube (length: 192 cm, Ø =40 cm) for stellate Sturgeon, Russian sturgeon and a larger tube (length: 250 cm, Ø =50 cm) for beluga Sturgeon. Each tube has 2 electrodes connected to an electronarcosis device which takes its power from a 12V DC car battery;
B. Electrodes are made of round stainless steel plates with perforations to allow water flow. These can be removed from the tube when the fish is introduced into / released from the tube;
C. Insulated copper cables (4 m) are used to connect electrodes to the electronarcosis device;
D. The electronarcosis device is able to output up to 35V DC, which can be controlled by a potentiometer and a digital voltmeter;
E. 12 V DC car battery;
F. Anchoring straps to attach the tube to the side of the boat (additionally, two side floats made of two thin pipes can be added to ensure buoyancy);
G. Tape straps to hold the fish with its abdomen above the water's surface during the operation.

Operation steps:

1. Half-submerging the tube in the water and attaching it with straps to the fishing boat;
2. Mounting the narcosis device in the boat and attaching the cables to the electrodes;
3. Introducing the fish directly from the river into the tube and fixing the electrodes;
4. Switching on the electronarcosis device;
5. Fish become immobile and show little or no response to alternative stimuli. It is possible to observe the fish moving its operculum (breathing) when it is under electronarcosis. The sturgeon loses the capacity to float and sinks to the bottom of the tube; during surgery the sturgeon will be kept under observation to ensure that the opercula are moving (fish are breathing):
6. Lifting and fixing the fish with a tape strap;
7. Biometric measurements;
8. Implantation of telemetry transmitters;
9. Switching off the electronarcosis device;
10. Releasing the fish immediately by lifting the electrode at the front of its head.

System scheme:



Textbox 1. Full description of the electronarcosis device coupled with a handling tube system used in adult sturgeon anesthesia in the river during surgical implantation of acoustic tags

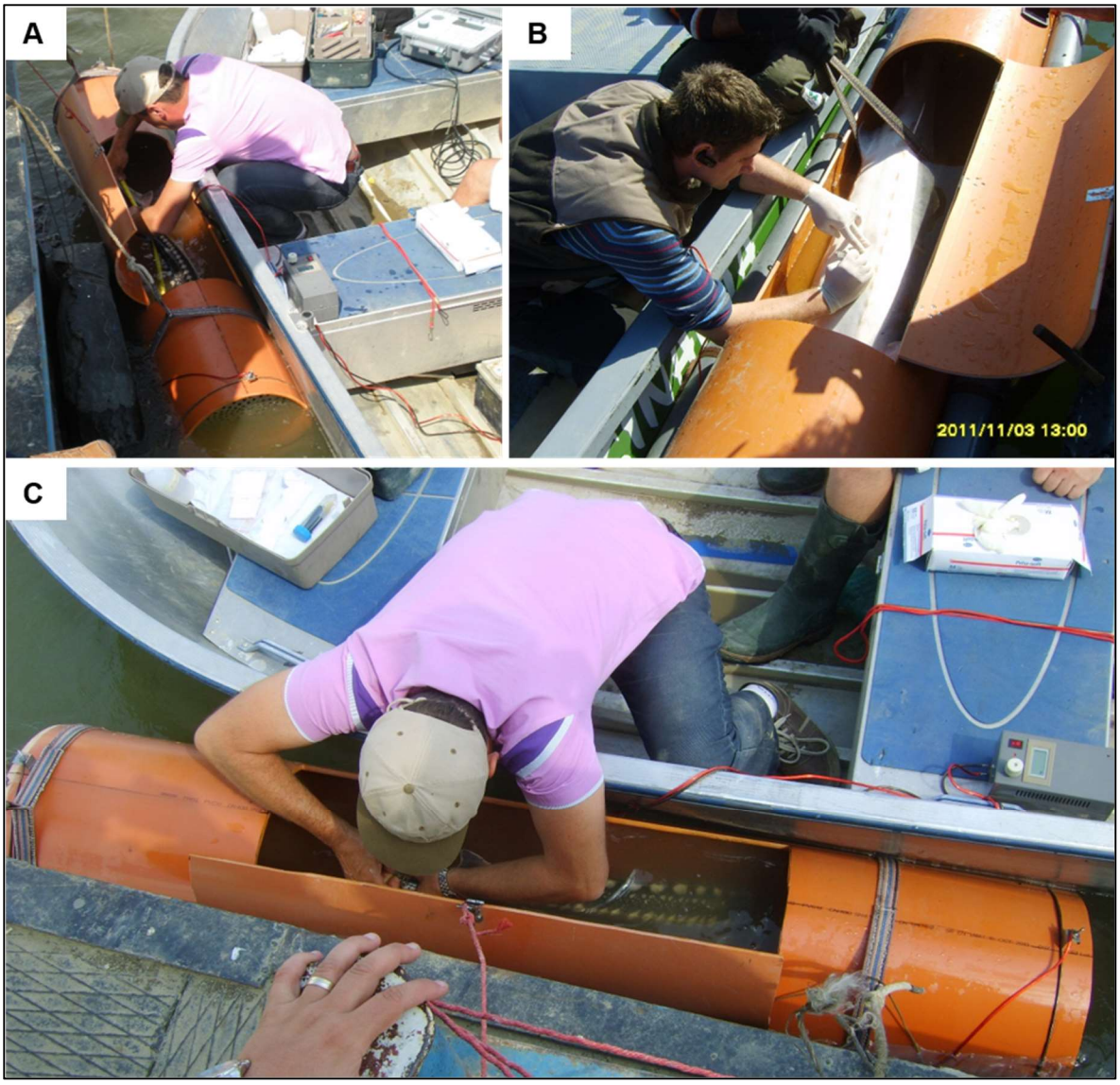


Figure 1. Electronarcosis using the small A) and large (B) operating tube on the Danube River. C- Tagging a stellate sturgeon with T bars under electro narcosis

The device provides an optimum voltage to harmlessly tranquillize the sturgeon during the handling or surgery (Snyder, 2003). Additionally the fish were local anesthetized with lidocaine to reduce stress and pain. This combination (operating tube - electronarcosis device) allows live fish anesthetizing and solves the problem of handling large fish by providing a fast and harmless fish anesthetizing method.

Since 2009, the DDNI has implanted acoustic transmitters in more than 50 wild adult sturgeons (Badilita et al 2012). The fish were caught on the Borcea branch of the Danube, from March to December.

The advantage of this method is fast recovery of the fish, immediately after switching off the current. Also, the behavior of beluga Sturgeon is unaffected if the fish are released directly from the tube into the river, most of them continuing their upstream spawning migration (Table 1).

Table 1. Examples of beluga sturgeons moving upstream (u/s) and downstream (d/s) after tagging using the electronarcosis handing method

No.	Species	Sex	Tagging Year	Release location	TL [cm]	SL [cm]	Short description of migration
1	*Huso huso*	male	Nov 2011	Borcea branch (≈Danube rkm 300)	205	186	- moves d/s after release - recorded at rkm 100 on 17 Nov. 2011 - returned after 5 years, recorded at rkm 847 on 19 April 2016 - recorded moving d/s at rkm 100 on 11 May 2016
2	*Huso huso*	male	May 2012	Borcea branch (≈Danube rkm 325)	210	180	- moves d/s, and was recorded at rkm 100 on 29 May 2012 - it returned 2 years later, when it was recorded at rkm 100 on 1 Nov. 2014 - overwintered in the river - continues its journey next year, arriving at rkm 847 on 7 April 2015 - leaves the area on 27 April 2015
3	*Huso huso*	male	Nov 2014	Borcea branch (≈Danube rkm 300)	200	170	- it moves d/s after release - recorded at rkm 100 on 1 Dec. 2013 - returned u/s to rkm 100 on 15th March 2014 - arrived at rkm 847 on 2 April 2014 - after six days, it moved d/s, last being recorded at rkm 100 on 26 April 2014.

CONCLUSION

The results show that handling is considerably reduced when the wild sturgeons are immobilized directly in the river, using an operating tube that provides unrestricted access to the sturgeons. There was no mortality recorded due to the use of electronarcosis during the tagging of wild sturgeon. Electronarcosis is suitable for immobilizing wild or farmed adult sturgeons for surgical implantation of telemetry transmitters, being a good alternative technique for immobilizing fish (Henyey et al., 2002). Compare with the chemical anesthesia where the whole procedure of tagging took more than 60 minute (extracting the fish from the river, chemical anesthesia, tagging and recovery from anesthesia), using electro narcosis the time is reducing to maximum 20 minutes . The method is reducing handling time and provides sufficient time to perform internal implantation procedures for implantation of tags into adult and young sturgeons. The device is easy to build and install, and the transport is relatively simple, both on land and water.

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